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ABSTRACT

The development of future performance trend indicators is based on the current value approach to human resource accounting. The value attribution portion of the current value approach is used to estimate the dollar value of observed changes in the state of the human organization. The procedure for value attribution includes: prediction of changes in organizational effectiveness due to changes in the human organization; establishing the dollar value of the predicted changes; and discounting and capitalizing the dollar values to arrive at the current and investment value of the changes in human organization. This procedure is illustrated using: (1) previously derived relationships between the state of the human organization and two measures of its effectiveness; (2) observed changes in the human organization; and (3) estimated dollar values of the effectiveness criteria. The results indicate that even moderate changes in the human organization can be of significant value to the organization. The value attribution progress and its results are discussed from several perspectives and the accuracy of predictions is investigated. Desirable characteristics of the criterion variable, problems of change in the nature of the predictor-criterion relationship, and the utility of prediction are discussed. (Author/GDC)

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TECHNICAL REPORT

January, 1978

FUTURE PERFORMANCE TREND INDICATORS: A CURRENT VALUE APPROACH TO HUMAN RESOURCES ACCOUNTING

REPORT V

THE VALUE ATTRIBUTION PROCESS

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The development of Future Performance Trend Indicators is based on the Current Value Approach to Human Resource Accounting. This report presents the Value Attribution portion of the Current Value Approach whereby the dollar value of observed changes in the state of the human organization is estimated. A general procedure for Value Attribution is presented. The procedure includes: (1) prediction of changes in organizational effectiveness due to changes in the human organization; (2) establishing the dollar value of the predicted changes: and

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discounting and capitalizing the dollar values to arrive at the current value and investment value of the changes in human organization. This procedure is illustrated using (1) previously derived relationships between the state of the human organization and two measures of its effectiveness; (2) observed changes in the human organization; and (3) estimated dollar values of the effectiveness criteria. The results of the illustration indicate that even moderate changes in the human organization can be of significant value to the organization.

The Value Attribution Process and its results are discussed from several perspectives. A limited investigation of the accuracy of predictions is conducted. Desirable characteristics of the criterion variable, problems of change in the nature of the predictor-criterion relationship and the utility of prediction are among a variety of issues regarding utilization of Future Performance Trend Indicators that are addressed. A summary of utilization issues to be discussed in a subsequent report is also presented.

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I. INTRODUCTION

The conception of organizations as open, living systems (Katz and Kahn, 1966) draws attention to the inherent diversity of inputs, throughputs and outputs utilized in the production and maintenance activities of any organization. Managers have traditionally been concerned with maximizing the instrumental efficiency of organizations by fully utilizing available physical, technical and financial resources. The wide variety of techniques for measuring and utilizing these resources (e.g., financial accounting, systems analysis, industrial engineering) have not only permitted this emphasis but have more than likely encouraged it since managers tend to attend to those things they can measure (Cammann, 1976). Similarly, the general inattention to the human and social resources upon which every organization relies and to the organization's "social efficiency" has been both a cause and effect of the inability to measure these resources and determine their actual and potential value to the organization. The purpose of this research is to explore and demonstrate one method for providing the information about the human and social resources necessary for their increased utilization.

It has only been recently that Brogden and Taylor's (1950) suggestion for measuring the value of an employee to the organization has stirred much activity. Three distinct approaches to what has become known as human resources accounting (Hermanson, 1964) have been developed.

1. The "Incurred Cost" method: measuring the amounts already invested in the human organization (Brummet, Pyle and Flamholtz, 1968; Pyle, 1970a; 1970b).
2. The "Replacement Cost" method: estimating the cost of replacing the organization's human resources (Flamholtz, 1969).

3. The "Present Value" method: estimating the future productive potential of today's human resources (Likert, 1967; Likert, Bowers and Norman, 1969; Likert and Bowers, 1973).

The present research focuses on developing and demonstrating the methodology for the Present Value, also called Current Value, approach to human resources accounting. This approach rests on the relationship between the state of the human organization "today" and the effectiveness of the organization "tomorrow." The Current Value approach is designed to use this relationship to predict future changes in productive potential which will result from a human organization that is somehow "better" or "worse" at present than it was at sometime in the past. The predicted changes in productivity, when expressed in dollar values, can be discounted to account for the timing of their predicted occurence. These discounted values give us the current value of observed changes in the human organization which will cause future changes in productivity.

Two key features of the current value method are evident. First, the dimension of time, so often ignored in the social sciences, is an integral part of the approach. Second, we are examining changes in the human organization and productivity rather than attempting to establish the absolute value of an employee or employee group. The title "Future Performance Trend Indicators" (FPTI) for the present research reflects both of these features.

The development of a current value methodology depends on the following conditions (Likert and Bowers, 1973):

1. the availability of scientific knowledge which identifies key dimensions of human organizations;
2. the adequacy of methodology and instruments for measuring these key dimensions;

3. the availability of reliable and valid performance data;
4. the availability of knowledge of the relationships between key dimensions of the human organization and performance outcomes;
5. the availability of knowledge of the persistence of changes in the human organization after they have occured;
6. a statistical technique for computing the current value of the human organization.

Pecorella and Bowers (1976a) discussed the general state of current knowledge with regard to the above conditions. The present development of FPTI's can be viewed in two phases: first, an attempt to empirically demonstrate the feasibility of meeting these conditors and second, once the conditions have been met, to demonstrate the process whereby future performance trends may be predicted and the current value of those predicted trends computed. The process whereby this latter phase is accomplished is called value attribution. Thus far, the development of the FPTI's has dealt primarily with the first phase. The present report moves us into the second phase, the value attribution process.

Because of the illustrative quality of this research it is useful to distinguish between the analytic processes being demonstrated and the products of the analyses as performed in the context of specific data. Our orientation to the development and demonstration of a methodology means that our primary interest is in the analytic processes. This is not to deny the importance of the specific numeric results of these analyses. In an implemented system of FPTI's, the final product of the analyses would be of primary interest. In the present research the numeric results of various analyses are of interest for one or more of the following reasons:

1. as the bases of subsequent analysis;

2. as important research findings in their own right;
3. as suggestive of additional issues to be investigated in the Current Value Method;
4. as an example of the type or range of outcomes one might expect from a functioning FPTI system.

Thus we distinguish between the process of analysis which is the primary concern of the current research and the products of the analyses which, while of secondary concern, are still of importance and interest. With this process-product distinction in mind, let us now turn to a brief review of previous reports and an overview of the present report.

The first of the six conditions listed above has been met by the development of the Survey of Organizations (S.O.O.) (Taylor and Bowers, 1972) which describes the human organization in terms of 16 indices which define five dimensions. A previously collected data set (Bowers, 1973) contained S.O.O., production and absenteeism measures for a variety of industrial firms. The first series of analyses (Pecorella and Bowers, 1976a; 1976b) was conducted to construct, from these data, if possible, a data file suitable for the development of FPTI's. These analyses were responsive to the requirements for the FPTI methodology, particularly items 2 and 3 above, and to the characteristics of the original data. The outcome of these analyses consisted of a data file suitable for the development of FPTI's. The characteristics of this file and the interplay of those characteristics with the FPTI methodology have been described elsewhere (Davenport et al, 1977). Briefly, the characteristics of the file are as follows:

1. Independent (Predictor) Variables:

   13 S.O.O. indices measured at two points in time, T_o and T_o' (typically, $T_o' - T_o = 1$ year) for work groups drawn from five industrial organizations.

2. Dependent (Criterion) Variables:

A. Total Variable Expense (TVE). A measure of productivity defined by the ratio of actual performance to scheduled or standard performance.

B. Absenteeism (ABS). A measure of absenteeism defined by a ratio of observed absence to scheduled work days (see Pecorella and Bowers, 1977, for a more complete definition of these measures).

Monthly TVE and ABS measures are each available for a different subset of four of the five industrial organizations. Neither measure is available for all months for all organizations. Both ABS and TVE were measured at the cost center level, where a cost center includes one or more work groups. To obtain work group scores on these performance measures, the cost center score was assigned or imputed to all work groups in that cost center.

To increase the internal consistency of the performance measures, multi-month performance periods were defined for each performance measure and organization separately. A performance period contains one or more sequential months for which the performance measures are more similar to each other (similarity is measured by Pearson r) than they are to those months not in the performance period. A work group's performance score for a period is the average of its scores for the months composing that period. Both the performance periods and months are defined in terms of their distance from either S.O.O. administration. For example, the third month after the first S.O.O. administration is month $T_o + 3$. Within each performance measure, periods are roughly comparable across organizations in terms of their time since the S.O.O. administration. The absolute length of the periods varies from one to 11 months. Table 1-1 shows the number of work groups from each organization for which the 13 S.O.O. indices and performance data were available for each of the periods of interest in this report.

Table 1-1.

NUMBER OF CASES BY PERIOD AND ORGANIZATION

TVE		C	D	E	F	G	H	I	
ORGANIZATION	II	61	61	61	--	--	--	--	
	III	254	254	254	--	--	--	248	
	IV	--	67	--	67	--	--	--	
	VI	127	127	127	131	51	51	161	
	Total	442	509	442	198	51	51	409	

ABS		C	D	E	F	G	H	I	J
ORGANIZATION	I	21	21	21	21	21	18	18	18
	II	46	107	46	76	61	24	--	--
	III	254	--	254	254	254	248	248	248
	VI	114	--	114	--	--	--	--	--
	Total	435	128	435	351	336	290	266	266

All subsequent analysis have been carried out separately for the ABS and TVE measures. The work groups from all organizations in each performance period were grouped together to represent a single, large "composite" organization with characteristics of a large, diverse manufacturing operation (Pecorella and Bowers, 1977). To equate the means and variances of performance measures from each organization, each measure was standardized within the organization and across periods. The imputation, standardization and performance period definition processes have been described here because they have implications for the analyses to be illustrated in the present report. These implications will be dealt with as they arise.

The next series of analyses (Pecorella and Bowers, 1977; Davenport et al., 1977) addressed the fourth condition above: the relationship between the human organization and performance outcomes. These relationships were established using multiple linear regression and examined with a variety of statistical techniques including double cross validation and examination of residuals. Evidence for a time lag between the condition of the human organization and its influence on performance was found in the systematic variation of the magnitude of the relationship between these two sets of variables. The final product of these analyses was the definition, in terms of the regression weights, of the relationships between the S.O.O. and performance measures for the periods encompassing $T_o + 1$ year. Also included in these analyses was an examination of the use of change scores and the reliabilities of the S.O.O. change scores.

As noted by Pecorella and Bowers (1976a), available knowledge indicates that changes in the human organizations are reasonably persistent (condition 5), although further research is needed here. The data in the present study are not suitable for an investigation of this issue.

The last condition, a statistical technique for computing the current value of the human organizations, has been met in a technique presented by Likert and Bowers (1973) and expanded to the multivariate case by Davenport et al. (1977). This technique is central to the accomplishment of the value attribution process described in the present report and in fact forms a bridge from the first phase of the research to the value attribution process presented in this report.

The present report consists of four sections beyond this Introduction and reflects our orientation to the development and illustration of a methodology. Section II presents a general approach to the value attribution process. Some specific requirements for this process in addition to the six conditions noted above are discussed. A three step value attribution process is presented with a brief discussion of some issues surrounding each of these steps.

Section III illustrates the value attribution process using the data file described above and the predictor-criterion relationships observed in these data. Because of the characteristics of this file, the illustration is somewhat more complex than the general description in Section II.

Section IV investigates the assumption used in the value attribution process that a previously observed relationship between the S.O.O. and performance measures can be used as a reasonable estimate of the relationship between the same variables at a specified time in the future.

Section V summarizes the present report, paying particular attention to issues which need further attention before a system of FPTI's can be implemented as an operating management tool.

II. THE VALUE ATTRIBUTION PROCESS

As the second phase of the establishment of a system of FPTI's, the value attribution process depends on the ability to meet the six conditions listed in Section I. An additional set of requirements can be stated which refer specifically to the conduct of the value attribution. While these requirements may be implicitly contained in the more general conditions, it is worthwhile to state them explicitly. Assuming that the future for which we will predict performance changes is to occur after some time, T_o', these requirements are:

1. measures of the human organization at some time, T_o, and at a subsequent time T_o';
2. knowledge of the relationship between the human organization and performance at a specific time or times subsequent to T_o';
3. knowledge of the dollar value of the performance measures.

The first requirement addresses the necessity of observing change in the state of the human organization. Relevant issues surrounding the computation, reliability and use of change scores have been previously examined (Davenport et al., 1977). It was shown, both theoretically and empirically, that it is possible to have reliable change scores which are based on observation of change in reliable measures.

The relationship of measures of the human organization to effectiveness criteria at $T_o + k$ is expressed by a vector of regression weights for each value of k. The second requirement is met by assuming that the relationship at $T_o' + k$ is the same as at $T_o + k$, i.e. we assume $\underline{B}_k = \underline{B}_k'$. This assumption is explored in Section IV of the present report.

The third requirement is necessary if we are to relate predicted performance changes to changes in the current dollar value of the human organization. The costing relationships in the present study are developed in Section III, while more general features of this relationship will be discussed in the present section.

Given the ability to meet these requirements, the value attribution process consists of three steps. The first step is the prediction of changes in performance. The second step is the valuation in dollars, or costing of the predicted performance changes. The final step is the discounting and capitalization of these anticipated cost changes.

The purpose of this section is to describe the value attribution process and its component steps in generic terms. In addition, several issues associated with the process as a whole or with specific steps will be discussed. It is our intent to provide both general guidance pertinent to implementing an FPTI system and a framework for understanding the illustrative analyses presented in Section III.

1. Prediction of Performance Changes

In essence this step is quite straightforward. As noted above, a relationship between the state of the human organization and organizational performance observed at $T_o + k$ is assumed to estimate the relationship between the same variables at $T_o' + k$. Change in the human organization measures observed from time T_o to time T_o' is then entered into this relationship to predict a change in organizational performance at $T_o' + k$, relative to performance at $T_o + k$.

Two characteristics of this procedure should be noted. First, the general linear relationship between predictor variables and the criterion can be expressed as:

(2-1) $\hat{\underline{Y}} = \underline{B}_0 + \underline{BX}$

where:

$\hat{\underline{Y}}$ = vector of predicted criterion scores

$\underline{B}_0$ = constant valued vector

$\underline{B}$ = vector of regression weights

$\underline{X}$ = matrix of predictor variables

However, when using the relationship expressed in equation (2-1) to predict change in the criterion from change in the predictors we use the following relationship:

(2-2) $\Delta\hat{\underline{Y}} = \underline{B}(\Delta\underline{X})$

where:

$\Delta\hat{\underline{Y}}$ = vector of predicted criterion change scores

$\Delta\underline{X}$ = matrix of predictor change scores

As shown by equation (2-2), it is necessary to omit the regression constant (B_0) when computing criterion change from observed change in the predictors (Davenport et al., 1977).

The second characteristic to be noted arises from the existence of a time lag between the observation of change in the predictor variables and the effect of these changes on the criterion variable (Pecorella and Bowers, 1977). Because of this time lag the nature of predictor-criterion relationship varies as a function of time since measurement of the predictor. Therefore, it is important to specify the amount of this time lag (denoted by the variable k) and to insure that the time lag involved in the estimation of the predictor-criterion relationship is the same as the time lag for which the prediction of the change in the criterion is made.

The basic process described above can be elaborated in a variety of ways. When the S.O.O. is used to measure the state of the human organization, these predictions will be made at the work group level. It is possible, however, that a different theoretical approach and/or statistical and measurement considerations

could lead to prediction at a different level. Furthermore, even when predictions are made at the work group level, it may be desirable or necessary to aggregate the predicted criterion changes to a more inclusive level. An example where this is necessary is provided by the present study. In general, however, it would appear most useful to retain the work group level predictions until after the costing and capitalizing processes. This allows consideration of differences in the capitalized dollar values among work groups. The capitalized values can then be aggregated to whatever level is desired.

Another consideration besides the level at which predictions will be made and the subsequent level of aggregation is the inclusion of predictors which do not measure the state of the human organization but increase the R of the prediction equation. A previous report (Davenport et al., 1977) showed how inclusion of certain organizational characteristics (e.g., organizational size) may increase the R. If variables such as these are added to the equation, care must be taken not to attribute changes in the value of the human organization to changes in these predictors. When the predictor-criterion relationship varies with the value of an additional variable, i.e., when there is interaction, different relationships must be developed for different values of this variable if the interaction is to be accounted for. This is the approach taken with respect to time lag in the present study.

2. Criterion Change Valuation

There are several reasons for valuing organizational effectiveness criteria in dollar terms. When this is possible, establishing the dollar value of these predicted changes expresses them in a metric common in the operation of the organization. Not only can different effectiveness criteria be compared (e.g., TVE and ABS) but these predicted cost changes can also be subject to standard financial accounting procedures. The cost changes due to changes in the human organization can then

be compared to cost changes predicted to occur as a result of changes in other sectors of the organization. The dollar values and the accounting methods by which they are constructed have high face validity and would appear more likely to be accepted by potential users than a less common measure. Furthermore, depending on the accounting practices of the firm, it may be possible to collect much of the criterion and costing data with minimal disruption to day-to-day operations (Mirvis and Macy, 1976).

Since the accuracy of the estimates of the dollar value of the criterion is dependent on both the way the criterion is defined and the costing procedure, we will touch on both factors here. The model used herein (Pecorella and Bowers, 1976a) postulates that certain organizational conditions, measured by the S.O.O., influence employee behaviors. Other models (Macy and Mirvis, 1976) have assumed that these behaviors result from employee decisions about their job performance (Lawler, 1973) and about attendance (March and Simon, 1958). Whether or not one desires to postulate employee decisons as an intervening variable in the causal chain from organizational conditions and practices to employee behavior, it is useful to categorize behaviors and their outcomes as either attendance (e.g., absenteeism, turnover, tardiness) or performance (e.g., quality and quantity in relation to a production standard, equipment and material utilization, accidents) related.

Macy and Mirvis (1976) have identified three criteria which behavioral variables should meet if they are to be costed and used for human resources accounting:

1. The behavior must be significantly affected by the work structure. This precludes, e.g., inclusion of attendance behaviors such as absence due to jury duty and changes in productivity due to fluctuations in demand, both of which are caused by extra-organizational factors.

2. The behavior must be measurable and convertible to significant costs to the organization. Attendance behaviors can usually be defined and measured at the individual level. Performance behaviors may be definable and/or measureable either at the individual level or group level, or both.

3. The measurement and cost of each behavior should be mutually exclusive from the measurement and cost of other behavors. This requires that outcomes and costs of the same behavior, which may be reflected in different organizational accounts, be disaggregated and perhaps recombined to provide measures and costs of the outcomes of interest. For example, the costs of absenteeism may be reflected in increased overtime and also in decreased product quantity and/or quality. Therefore, the current value of changes in the causal variables for absenteeism should include change in production cost attributable to changes in absenteeism as well as the changes in overtime costs.

Using their criteria, Macy and Mirvis (1976) have developed a series of "standardized" definitions of behavioral outcomes. While it is unlikely that these particular definitions would be valid for all industrial, service and government organizations, the approach demonstrates both the importance and the feasibility of establishing standard measures which are appropriate criteria for FPTI's.

Once the criterion behaviors have been defined and measured, their value or cost to the organization must be determined. As noted above, in order to achieve an accurate estimate of total costs, the costs of each behavior should be mutually exclusive. Furthermore only variable costs, i.e. those which vary directly with production or activity level, should be included since these are costs subject to influence of the employees' behaviors (Pecorella and Bowers, 1976a; Mirvis and

Lawler, 1977; Davenport et al 1977). Nonvariable or fixed costs which do not change with employee behavior must be excluded when valuing changes in this behavior. Mirvis and Macy (1976) provide an example of costing behavioral outcomes where variable, fixed and opportunity costs associated with each behavior are calculated. As they point out, the feasability of such a procedure depends on the accounting practice in use. The desirability of the procedure, however, depends on the intended use of the costing scheme. The FPTI and Current Value methodology is designed to reflect anticipated cost changes. By definition, fixed costs will not change as a function of employee behavior. However, it is possible that the way fixed costs are allocated may be altered, perhaps in turn altering the amount allocated to particular activities or behaviors.

The costing process and the level at which predicted criterion changes are aggregated are also inter-related. If the relationship of dollar value to criterion change is constant across all organizational units at all levels, then criterion changes may be aggregated to whatever level is desired prior to costing. If the valuing relationship varies across organizational units then the criterion changes cannot be aggregated, prior to assigning dollar values, to any level higher than the lowest level at which the valuing relationships are different across units. For example, in the present study the relationship between criterion change and dollar value is the same for all work groups in a cost center but is different for separate cost centers. Thus we can aggregate criterion changes to the cost center level prior to costing but would establish the value of the changes predicted for each cost center before further aggregation since we desire to reflect the differential value of the criterion for individual cost centers. Although the data in the present study do not meet all the above requirements for valuation, the value attribution example in Section III will provide a concrete illustration of many of the issues mentioned here.

3. Capitalization and Discounting

The completion of the costing or valuation step in value attribution results in a series of cost changes predicted to occur at specified future times. Discounting and capitalization are two accounting techniques which may be applied to this stream of anticipated income in order to make it comparable to other financial information available for decision making. Discounting adjusts the magnitude of the predicted cost changes to account for their differential timing. This is done because the present value of x dollars depends on the time at which the x dollars will be received (expended). Capitalization, as the term is used here, expresses the present value of future cash flows in terms of their investment value. Whether a decision maker will use present values or investment values is a function of the nature of the decision to be made. This will be further elaborated after we discuss the discounting and capitalization processes.

Discounting. The discounting process accounts for the differential timing of future cost changes by expressing them in terms of the current dollars which, when invested at a given interest rate, would have a value equal to the future cost changes at the point in time when the changes are predicted to occur. Weston and Brigham (1966) provide the standard discounting formula (p. 169). Substituting our terminology and assuming that "present" time is T_o', we have:

$$(2\text{-}3)\quad PV = \sum_{k=1}^{n} \frac{PC_k}{(1+i)^k}$$

PV = present value of PC_k for k = 1 through n.

PC_k = predicted cost change at time k.

i = interest rate per unit of time (usually month or year).

k = number of time units between "present" time and occurence of predicted cost change.

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original document.

4. General Issues

In addition to the three steps above there are two general issues that need to be considered in any FPTI implementation. The first is the level of aggregation of the predicted changes at various stages in the attribution process. This has been addressed in the context of each of the three steps above.

The second issue is the notion of the prediction of change. We are not concerned here with the psychometric problems of measuring change which were discussed in Davenport et al.(1977). Rather, our interest is in pointing out that at the end of the capitalization process we have a figure or figures which reflect an anticipated change in costs of operating the organization. This is a change from a previous level of costs which is attributed to change in the state of the human organization. The previous level of costs is the total value of the criterion as estimated by the prediction equation at $T_o + k$, i.e., it is $\hat{Y}$ in equation 2-1, at $T_o + k$. While the Current Value approach makes no attempt to establish this value in absolute terms, it is clear that predictions of change from this level will be most useful when this previous level of costs is a relatively recent one. That is, it is more useful to estimate that costs will be $100,000 less than they were last year than to estimate that they will be $100,000 less than they were three years ago. Furthermore, if these predictions are to be made on a continuous and regular basis, then the measurement of the organization will have to be done on a similar basis. This would allow for constant updating of the predictor-criterion relationship. All this is to say that the nature of our cost predictions, i.e. change from a previous cost level, plus the continuous updating of predictive relationships, argue for a regular measurement program in which careful consideration is given to the timing of the measurement.

It should also be remembered that the predicted cost changes, caused by changes in the state of the human organization, could occur whether or not we measure and predict them (disregarding the impact of the isolated measurement intervention). We are identifying the causes of costs of operating which were previously unidentified beyond perhaps "good management" or "apathetic workers." The ability to predict these changes in effectiveness and compute their dollar value, combined with the ability to estimate the efficacy of various interventions for producing changes in the causal variables, provides a potent tool for deciding where the investment of limited funds will produce the greatest return.

III. AN ILLUSTRATION OF THE VALUE ATTRIBUTION PROCESS

Introduction

This section illustrates the value attribution process with a subset of the data which have been used thus far. These data have certain characteristics, described briefly in Section I, which require that the three step process described in Section II be expanded to a six step process. Characteristics of the data and other influences on the analyses will be discussed at the point where they are most relevant. The six steps in the illustration are:

1. Compute predicted changes in organizational effectiveness criteria (ABS & TVE).
2. Convert predicted changes to raw score form.
3. Aggregate changes predicted for work groups to cost center level.
4. Cost predicted cost center effectiveness changes and aggregate to the organizational level.
5. Convert organizational cost changes predicted by performance period to changes predicted by month.
6. Discount and capitalize predicted monthly organizational cost changes.

Steps 1, 4, and 6 follow directly from the three step process described in Section II. Steps 2, 3, and 5 arise from particular characteristics of these data. It should be noted that to the extent that other data have characteristics similar to these, the above steps or ones similar to them will not be unique to this illustration. Prior to the actual illustration we will "set the stage" by dealing with some relevent issues and placing this illustration in the context of the overall research effort.

Selection of Work Groups for Value Attribution

In Section II it was noted that one of the requirements for value attribution is the availability of measurements of the human organization at two different points in time. There are 797 work groups in the present data set for which T_o and T_o' S.O.O. scores are available. These 797 work groups come from all five organizations. The second requirement for value attribution is knowledge of the relationship between the S.O.O. scores and ABS and TVE. These relationships were developed for each criteria using data from two different subsets of the five organizations (Organizations II, III, IV and VI (plants 1, 2 and 3) for TVE; Organizations I, II, III, and VI (plants 2 and 3)) for ABS. In addition, the particular Organizations and work groups within an Organization used to compute the period equations for each criterion varied from one period to the next, depending on which Organizations had criterion data for that period.

There are several alternative methods for the selection of work groups for which predictions will be made. At one extreme, we could predict changes in TVE and ABS for all 797 work groups with T_o and T_o' S.O.O. scores. Selection of this alternative would result in application of the observed relationships to some work groups outside the population of work groups for which each equation was developed. The alternative, towards the other extreme, would be to predict only for those work groups which were included in the calculation of each prediction equation. Operationally, this would mean predicting effectiveness changes for each period only for those work groups with T_o and T_o' S.O.O. scores and with criterion data in that period. This procedure would select a subset of the groups used to calculate the prediction equation. This seems too conservative, however, in that Pecorella and Bowers (1977) found that the relationships are generalizable to work groups not used in the development of the equations as long as the work groups are

drawn from the same organizational population as those used in the development of the equation. This finding suggests a third alternative: that we predict for all work groups which meet the following criteria:

1. have T_o and T_o' scores on 13 S.O.O. indices;
2. belong to a cost center which has criterion data on the criterion being predicted, for at least one performance period;
3. belong to an organization which is represented by one or more cost centers in the period being predicted.

Adoption of these criteria would result in the number of work groups for which predictions are made remaining constant for each organization across periods in which that organization is represented, but varying across periods according to which organizations were used in the development of the equation for each period. This varying number of work groups from one period to the next would make discounting and capitalization of the predicted savings across periods at best difficult to interpret, since the size of each organization for which we are predicting would vary drastically across time.

There are two solutions to this problem of the size of the organizations varying across time. One is to predict only for those work groups which come from a cost center that has criterion data for at least one period and from an Organization that is represented in all performance periods. This would mean predicting TVE changes only for Organization VI, plant 3, and ABS changes only for Organization I. The other choice is to predict for all work groups that come from a cost center that has criterion data for at least one period and from an Organization that is represented in at least one performance period. Because this is an illustration of the process of value attribution and not an attempt to make attributions which are as accurate as possible for individual Organizations, we have opted to maximize the number of cases and chosen the second alternative, even

though it means that in some periods we will make predictions for one or more Organizations which were not used in the development of the equation for that period.

In summary, our criteria for the selection of work groups for the value attribution phase are as follows:

1. have T_o and T_o' scores on all 13 S.O.O. indices;
2. belong to a cost center which has criterion data for at least one of the performance periods of interest (TVE C-I, ABS C-J);
3. belong to an Organization or plant that entered into the calculation of the prediction equation for one or more of the periods of interest.

These criteria provide us with two subsets of the 797 work groups with T_o and T_o' S.O.O. scores which are constant across periods for each criterion. The actual number of work groups from each Organization along with the number of respondents and cost centers represented by these work groups are shown in Table 3-1.

Finally, it should be noted that the appropriateness of making predictions for Organizations which were not included in the development of the prediction equation depends on the generalizability of the equations across Organizations. While this is unknown, it is reasonable to expect that the equations are less generalizable across Organizations than within Organizations. The impact of this procedure on the final present value figures will be decreased considerably by the month to period conversion procedure to be described in Step 5 of this Section.

In addition to selecting the organizations and work groups for which predictions will be made we must determine the period of time over which we will estimate future performance. Since most organizations have an accounting cycle of one year, we will predict future performance changes throughout one year following the collection of the wave 2 S.O.O. data, i.e., through T_o' + 12 months.

Table 3-1

NUMBER OF WORK GROUPS AND ASSOCIATED COST CENTERS AND WORK GROUP MEMBERS TO BE USED IN VALUE ATTRIBUTION, BY ORGANIZATION AND CRITERION

	TVE			ABS		
	Work Groups	Cost Centers	Individuals	Work Groups	Cost Centers	Individuals
ORG I	---	---	---	19	10	154
ORG II[1]	62	15	277	62	15	277
ORG III	162	11	1233	162	11	1233
ORG IV	104	14	1006	---	---	---
ORG VI[2]						
Plant 1	49	31	425	---	---	---
Plant 2	38	20	428	38	20	428
Plant 3	92	36	1132	92	36	1132
Total	507	127	4501	373	92	3244

[1]These 62 work groups come from all four plants in ORG II. Only two of the plants were used in calculation of TVE equations while all four were used in calculation of ABS equations. Predictions for all four plants will be made for both criteria because plants were similar enough to be trested as a single Organization (Pecorella and Bowers, 1976a).

[2]ORG VI consists of three plants which have been treated separately throughout the analyses. Thus, TVE would be predicted for all three plants which were used in the calculation of the TVE equations and the ABS will be predicted for the two plants (2 and 3) which were used in the calculation of ABS periods.

This will involve use of prediction equations from periods C-I for TVE and C-J for ABS.

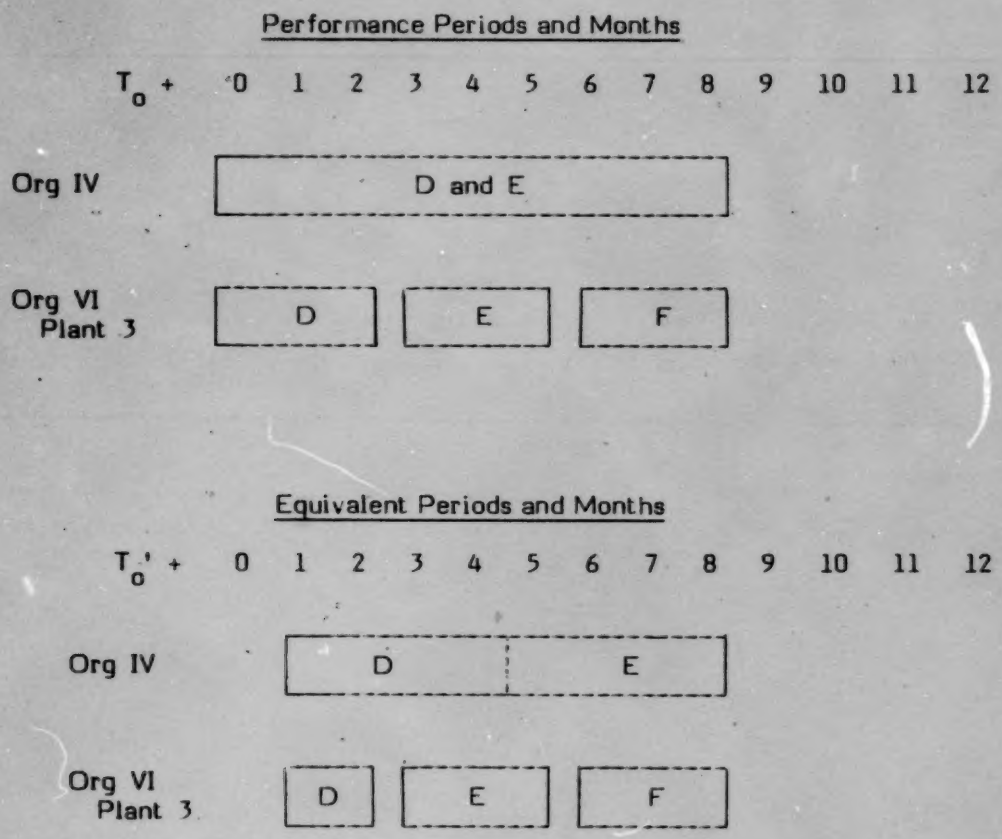
Lag Time, Months, and Periods

As indicated previously, there is a change in the predictor-criterion relationship over time (Pecorella & Bowers, 1977) and this change has implications for the prediction of changes in the criteria (Davenport el al., 1977). Specifically, a relationship between the S.O.O., measured at T_0, and the effectiveness criterion measured k units of time later, at $T_0 + k$, will be used to predict a change in the criterion. This change is predicted to occur at $T_0' + k$, i.e., k units of time after the second S.O.O. measurement at T_0'. The parameter k is what has been previously called lag time (Pecorella & Bowers, 1977).

The time units in this research are periods and months. When months are used, it is straightforward to define the month(s), $T_0' + k$, for which predictions are made using the relationship developed at $T_0 + k$. However, when k is expressed in periods, it is not quite so clear when $T_0' + k$ occurs. For our purposes here, we will define an equivalent performance period comparable to each original performance period for which a prediction equation was developed. Any such equivalent period is defined as including the same months relative to the second S.O.O. administration (T_0') as the original period contained relative to the first S.O.O. administration (T_0). Figure 3-1 provides an example of this notion of equivalent periods. In Organization IV, TVE period D-E consists of months $T_0 + 0$ through $T_0 + 8$; in Organization VI, Plant 3, TVE period D consists of months $T_0 + 0$ through $T_0 + 2$; E contains $T_0 + 3$ through $T_0 + 5$ and F contains $T_0 + 6$ through $T_0 + 8$. These are shown in Figure 3-1. The time periods for which we shall predict TVE changes for each Organization subsequent to T_0' are periods constructed such that they are equivalent to the time periods subsequent to T_0 for which the equations were

Figure 3-1

RELATION OF PERFORMANCE PERIODS AND EQUIVALENT PERIODS



developed. Figure 3-1 shows these equivalent periods. For Organization IV, equivalent periods D and E contain months $T_o' + 0$ through $T_o' + 8$. Thus we shall use the prediction equations developed for periods D and E to predict for months $T_o' + 1$ through $T_o' + 8$ (we do not predict for $T_o' + 0$) for Organization IV. In this case we would apply period D's equation to $T_o' + 1$ through $T_o' + 4$ and period E's equation to $T_o' + 5$ through $T_o' + 8$. For Organization VI, plant 3, we would use the period D equation to predict for equivalent period D containing months $T_o' + 1$ and $T_o' + 2$. Period E and F equations are applied in a similar manner to predict for

equivalent periods E and F. The situation where no organizational period is defined for certain months due to missing criterion data is dealt with in Step 5 where the month to period conversions are made. Finally, whenever we speak of predicted change for a given period, it is to be understood that the change is predicted for a period equivalent to the original performance period of the same name for a given organization.

Process and Product

In Section I we distinguished the primary concern of the present research, i.e. the development and demonstration of the value attribution methodology as an analytic process, from the secondary, though still important, concern with the numeric outcomes or products of that analytic process as illustrated in the context of a particular data set. At this point it seems appropriate to both highlight this process-product distinction regarding the illustration of the value attribution process and at the same time to briefly place the illustration in the context of the overall research effort thus far, which itself can be described in terms of the process-product distinction.

While it would be possible to consider each of the many analyses and their outcomes as distinct processes and products, it is convenient to identify three major products and their related analyses. The first of these is the establishment of the S.O.O.-criteria relationships, including the findings regarding lag time. This "product" is essential to the process to be illustrated in the present section. The reliability and validity of the data used to establish these relationships and the relationships themselves have been the subject of four previous reports (Pecorella & Bowers, 1976a, 1976b, 1977; Davenport, 1977). The obtained S.O.O.-TVE/ABS relationships are statistically and practically significant and in all likelihood underestimate the actual relationships.

The second product is the outcome of the first stage of the value attribution process: i.e., predicted changes in effectiveness criteria. As previously indicated, this requires knowledge of the S.O.O.-TVE/ABS relationship and evidence of change in the S.O.O. scores (Davenport et al., 1977), both of which we have, and an assumption that previously established S.O.O.-ABS/TVE relationships will be valid in the future. Given this assumption (examined in Section IV) we are able to predict the criterion changes. The accuracy of our predictions is influenced primarily by our ability to predict (indicated by the value of R), the correctness of our assumptions, and the reliability of our predictor change scores.

The costing process, followed by discounting and capitalization, yields the final product, i.e. the current dollar value of the predicted changes in the effectiveness criteria. This process requires: (1) criteria which are defined in accordance with the requirements listed in Section II, (2) the ability to determine costs to the organization of these criteria, and (3) knowledge of the timing of the future changes in effectiveness. This last is provided implicitly by our use of different prediction equations for different values of lag time. Because the data available for this research were not collected for the specific purpose of developing FPTI's, we do not possess all the information implied by items (1) and (2) above for all five organizations. We do, however, possess enough of this information to demonstrate the process by which this final product is obtained. Although the estimate of current value of changes in the human organization which is obtained in the demonstration of this process will not be as accurate as it would be in an actual FPTI implementation, it should be in the range one would expect, given the conditions and parameters which we will describe. Thus our inability to accurately cost the predicted criterion changes will effect the accuracy of our final result but does not detract from the demonstration of the process used to obtain that result or from the usefulness of that result as an indicator of the range of cost changes

that might be expected were we able to accurately determine the value of the criterion changes. We now turn to the illustration of the value attribution process using the six steps listed above.

1. Prediction of Changes in Effectiveness Criteria.

The relationship of the change in S.O.O. scores ($\Delta\underline{X}$) to predicted change in criterion ($\Delta\hat{\underline{Y}}$) was given by equation (2-2) as $\Delta\hat{\underline{Y}} = \underline{B}\Delta\underline{X}$.

Values of $\Delta\underline{X}$ were computed for all 797 work groups for which predictions are to be made. The mean and standard deviations of the $\Delta\underline{X}$ for each S.O.O. index are shown in Table 3-2. These statistics are shown computed for all 797 work groups and for the two subsets of work groups for which predictions will be made. The reliabilities of the change scores computed on all 797 work groups (from Davenport et al., 1977) are also shown.

The $\underline{B}$'s for each criterion period of interest (from Davenport et al., 1977) are shown in Table 3-3. Execution of the operations shown in equation (2-2) using the $\underline{B}$'s in Table 3-3 and the $\Delta\underline{X}$'s represented in Table 3-2 yields a predicted change in TVE and ABS for each work group for each of the periods of interest. The means and standard deviations of these predicted changes are shown in Table 3-4 for each period. In Table 3-4 a negative quantity indicates a predicted improvement in the organizational performance criterion.

2. Conversion of Predicted Changes to Raw Score Form.

As discussed by Pecorella and Bowers (1976b) and by Davenport et al. (1977), the regression weights presented in Table 3-3 were computed using criterion data which had been standardized across periods and within each organization. The conversion of the criterion data to standard scores alters (in this case, decreases) the magnitude of the regression weights. The magnitude of the regression weights, in turn, effects the magnitude of any predictions made using these weights. Thus,

Table 3-2

MEANS, STANDARD DEVIATIONS AND REHABILITIES OF CHANGE SCORES ON 13 SOO INDICES

	TVE (N=507)		ABS (N=373)		TOTAL (N=797)		
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$R_{\Delta x}$
SOO INDEX							
Supervisory Support	.045	.664	.091	.651	.070	.679	.86
Supervisory Goal Emphasis	.046	.605	.099	.590	.080	.632	.73
Supervisory Work Facilitation	.134	.695	.187	.667	.182	.714	.84
Supervisory Team Building	.123	.749	.200	.734	.166	.782	.84
Peer support	.008	.503	.043	.515	.019	.533	.80
Peer Goal Emphasis	.096	.551	.122	.536	.114	.582	.69
Peer Work Facilitation	.123	.606	.175	.598	.164	.644	.83
Peer Interaction Facilitation	.076	.660	.143	.650	.106	.699	.84
Human Resources Primacy	.048	.550	.576	.557	.047	.578	.71
Communication Flow	.110	.564	.166	.564	.125	.586	.64
Motivational Conditions	.006	.526	.051	.495	.024	.541	.59
Decision Making Practices	.085	.519	.102	.536	.089	.560	.36
Satisfaction	-.011	.498	.059	.473	.011	.520	.73

TVE = Statistics for work groups used to predict changes in TVE

ABS = Statistics for work groups used to predict changes in ABS

Total = Statistics for all work groups. $R_{\Delta x}$ is from Davenport et al. (1977, p. 13).

Table 3-3

BETA WEIGHTS FOR PREDICTIONS OF TVE AND ABS

	TVE						
	C	D	E	F	G	H	I
Supervisory Support	-.17555	-.04021	-.02063	.24337	-.29418	-.29767	-.07030
Supervisory Goal Emphasis	.20353	.24248	.16648	.10592	-.12580	-.43941	.04352
Supervisory Work Facilitation	-.00630	-.06977	-.02334	.15926	.34966	.32313	.10334
Supervisory Team Building	.02611	.00948	-.06070	-.48260	-.06603	.49962	-.10963
Peer Support	-.15249	-.09380	-.10912	.25140	.08940	.29487	-.08029
Peer Goal Emphasis	-.24554	-.25009	-.11746	.42923	.15495	-.14403	-.31091
Peer Work Facilitation	-.05815	-.19456	-.12499	-.97722	-.04795	-.31268	-.19232
Peer Interaction Facilitation	.44040	.38398	.36051	.51046	-.19970	.13590	.57676
Human Resources Primacy	-.16294	-.16463	-.36936	.56292	.23469	-.01118	-.17215
Communication FLow	-.38943	-.48789	-.25253	.14878	.08824	.12399	-.15804
Motivational Conditions	-.01472	.22501	.19181	-.19849	.02421	-.37802	.08388
Decision Making Practices	.02672	.02686	.05695	-.90434	-.20198	.15358	.20576
Satisfaction	.33829	.03748	-.00535	-.03477	.15442	-.08274	-.07647

	ABS							
	C	D	E	F	G	H	I	J
Supervisory Support	-.35387	-.12286	-.09911	.14929	-.21582	-.07133	.39141	-.22864
Supervisory Goal Emphasis	.12241	-.21631	.36472	.14842	.16558	-.07054	.05707	-.00076
Supervisory Work Facilitation	.18522	.27108	-.46797	-.11026	.01772	.13328	-.16584	.13054
Supervisory Team Building	-.04771	.07458	.19924	-.06599	.11636	-.02617	-.20138	.08197
Peer Support	-.17250	-.09903	.14298	.17288	-.06851	-.17588	.46732	-.20698
Peer Goal Emphasis	-.27301	.02057	-.19864	-.01931	.24858	-.11328	.02489	.04345
Peer Work Facilitation	-.25236	.18299	.30477	.16537	.28413	-.13064	-.12974	-.02875
Peer Interaction Facilitation	.44706	-.25277	-.27005	-.27351	-.15285	.50633	-.36227	.28559
Human Resources Primacy	-.02992	-.16707	-.37616	-.12823	-.12451	-.18422	.01404	-.16442
Communication Flow	.06572	.30429	-.10363	.02381	-.29979	-.11554	.41686	-.07937
Motivational Conditions	-.24122	-.13253	.46093	.04377	.19541	-.09696	-.03654	.14282
Decision Making Practices	-.12186	-.08815	.44863	-.18535	-.32057	-.11913	.33242	-.10209
Satisfaction	.32023	-.02681	-.26313	-.21633	.03280	.20076	-.62103	.01809

Table 3-4

MEANS AND STANDARD DEVIATIONS OF PREDICTED "STANDARD" SCORE CHANGES IN TVE AND ABS, BY PERIOD

		C	D	E	F	G	H	I
TVE	$\bar{X}$	-.047	-.077	-.043	-.094	.016	.057	-.018
(N=507)	SD	.286	.303	.261	.542	.217	.358	.253

		C	D	E	F	G	H	I	J
ABS	$\bar{X}$	-.013	.051	-.009	-.043	.001	-.001	-.016	.027
(N=373)	SD	.264	.225	.362	.229	.319	.260	.428	.220

N = number of work groups

the inverse of the linear transformation that was originally applied to the raw criterion scores must be applied to the predicted scores to return them to raw score form. For the univariate case we have:

(3-1) If $Z_Y = \frac{Y-\bar{Y}}{SD_Y}$

(3-2) and $\hat{Y} = B_o + BX$

(3-3) and $\hat{Z}_Y = B_{o_Z} + B_Z X$

(3-4) then $\hat{Z}_Y = \frac{\hat{Y}-\bar{Y}}{SD_Y}$ (See Appendix A)

(3-5) since $\hat{Z}_Y' = B_{o_Z} + B_Z X'$ (assuming $B_{o_Z} = B_{o_{Z'}}$ and $B_Z = B_{Z'}$)

(3-6) and $\hat{Y}' = B_o + BX'$ (assuming $B_o = B_o'$ and $B = B'$)

(3-7) then $\hat{Z}_Y' = \frac{\hat{Y}'-\bar{Y}}{SD_Y}$

(3-8) since $\Delta\hat{Z}_Y = \hat{Z}_Y' - \hat{Z}_Y = \frac{\hat{Y}'-\bar{Y}}{SD_Y} - \frac{\hat{Y}-\bar{Y}}{SD_Y}$

(3-9) then $\Delta\hat{Z}_Y = \frac{\hat{Y}'-\hat{Y}}{SD_Y} = \frac{\Delta\hat{Y}}{SD_Y}$

(3-10) and $\Delta\hat{Y} = SD_Y \cdot \Delta\hat{Z}_Y$

Y = "Raw" criterion score

B = Regression Coefficient used to estimate Y

B_Z = Regression Coefficient used to estimate Z_Y.

' = at or subsequent to wave 2 S.O.O. measurement

Equation (3-1) is the formula whereby standardized or 'Z' scores are computed. (3-2) is the regression equation for the least squares estimate of Y, $\hat{Y}$. (3-3) is the regression equation for the computation of $\hat{Z}_Y$ where $\hat{Z}_Y$ is defined by the function shown in (3-4). (3-5) shows the prediction of a score, $\hat{Z}_Y'$, using a value of X' on the predictor and the parameters B_Z and B_{o_Z}. (3-5) is the standard score form of (2-1). It is important to note that $\hat{Z}_Y'$ as computed in (3-5) is in general not a true standard score. It will not have a mean of zero and standard deviation of one unless these parameters for X' are identical to those for X. (3-7) shows the

relationship of $\hat{Z}_Y'$ to $\hat{Y}'$ when $\hat{Y}'$ is computed as shown in (3-6).[1] (3-8) is a definition of $\Delta \hat{Z}_Y$, which by algebraic manipulation becomes (3-9). Finally, the transformation of $\Delta\hat{Z}_Y$ to $\Delta\hat{Y}$ is shown in (3-10). Again, $\Delta\hat{Z}_Y$ is not a standard score but the difference between two scores which are linear transformations of "raw" predicted scores.

The predicted change scores represented in Table 3-4 are in the form of $\Delta\hat{Z}_Y$ scores and must be converted to $\Delta\hat{Y}$ form. This is done by equation (3-10). Since this original standardization was accomplished within organizations, the value of SD_Y is different for each organization. These values of SD_Y are shown in Table 3-5. Conversion of the distributions of predicted change scores represented in Table 3-4 to raw score form yields distributions of predicted raw scores for which the means and standard deviations are shown in Table 3-6.

3. Aggregation to the Cost Center Level

There are two different reasons for aggregating criterion changes predicted at the work group level to a more inclusive level. It may be computationally convenient for further steps in the value attribution process or it may be necessary because of the nature of the measures. The present step in the analysis is required by the imputation of original cost center ABS and TVE scores to the work groups in that cost center. This was done to provide an adequate number of work groups for development of the prediction equations. The imputation results in the criteria and the predicted criterion changes being of a magnitude appropriate for a cost center. In order not to inflate the predicted criterion changes and cost savings, it is

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[1] The effect of standardization within organizations (use of different SD_Y) on the multiple R's was discussed by Davenport, et al. (1977). There is a similar effect here on the relationship of $\hat{Z}_Y'$ to $\hat{Y}'$ so that (3-7) is only an estimation of the actual relationship. The findings in Davenport et al. (1977) indicate that the effect is small, however, and therefore (3-7) has been used as it stands.

Table 3-5

STANDARD DEVIATIONS OF TVE AND ABS SCORES USED TO CONVERT PREDICTED SCORES FROM STANDARD SCORE FORM TO RAW SCORE FORM

	TVE	ABS
ORG I	---	2.49
ORG II	2.99	4.79
ORG III	5.46	2.93
ORG IV	1.52	---
ORG VI		
Plant 1	0.24	---
Plant 2	0.36	4.00
Plant 3	1.95	2.81

Table 3-6

MEANS AND STANDARD DEVIATIONS OF PREDICTED RAW SCORE CHANGES IN TVE AND ABS, BY PERIOD

		C	D	E	F	G	H	I
TVE	$\bar{X}$	-.072	-.175	-.070	-.147	.067	.127	-.006
(N=507)	SD	1.07	1.09	.892	1.90	.728	1.22	.928

		C	D	E	F	G	H	I	J
ABS	$\bar{X}$	-.053	.163	-.012	-.128	-.014	-.015	.009	.084
(N=373)	SD	.895	.785	1.28	.816	1.07	.870	1.43	.734

N = Number of Work Groups

necessary to convert the predicted work group changes to cost center changes. This conversion is accomplished by averaging the changes predicted for each work group across all work groups in a cost center and assigning that average as the predicted change for the cost center. This is done in each period. The mean and standard deviation of the distribution of predicted cost center changes for each period are shown in Table 3-7.

4. Costing of Predicted Cost Center Changes and Aggregation to the Organizational Level

As was indicated earlier in this section, not all the data necessary to accurately cost the predicted criterion changes for each cost center are available. Therefore, our approach to costing the predicted criterion changes will be two-fold. First, we will use available data to estimate representative cost relationships. These estimated relationships will be used to cost the predicted criterion changes thus providing an estimate of the magnitude of the cost changes and an illustration of the costing process. Second, we will discuss some of the factors which could influence the costing process and the magnitude of the dollar figures arrived at when the criterion and cost relationships are of the form used herein.

TOTAL VARIABLE EXPENSE

The TVE Criterion and its Relationship to Dollar Costs. As described by Pecorella and Bowers (1977, p. 19), the four TVE measures are all somewhat different. However, closer examination shows that the measures from Organizations II and III are quite similar and the measures from Organization IV and VI are virtually identical. The major difference between these two sets of TVE measures (II and III vs. IV and VI) is the first two deal with hourly labor costs while the second two deal with all variable production costs. More importantly, all the TVE measures are of identical form, i.e. they are a ratio of actual cost (due to labor or total costs) to

Table 3-7

MEANS AND STANDARD DEVIATIONS OF PREDICTED RAW SCORE CHANGES IN TVE AND ABS AGGREGATED TO COST CENTER LEVEL, BY PERIOD

		C	D	E	F	G	H	I	
TVE	$\bar{X}$	-.065	-.138	-.070	-.168	.004	-.097	-.022	
(N=127)	SD	.455	.449	.402	.699	.235	.385	.310	
		C	D	E	F	G	H	I	J
ABS	$\bar{X}$	-.101	.231	.039	-.114	.015	-.077	.002	.067
(N=92)	SD	.662	.565	.693	.580	.990	.727	1.256	.691

N = Number of Cost Centers

budgeted cost (scheduled labor costs or total budgeted expense). The budgeted cost is the cost of performing the cost center's projected work if all work is accomplished according to engineered performance standards. For the purposes of this illustration of the value attribution process, we shall treat the TVE measures from all four Organizations as though they were a ratio of actual total costs to budgeted total costs. This will allow a uniform, somewhat simplified, costing procedure to be applied to the predicted changes in TVE from all four organizations. The effect of treating the labor cost based TVE measures from Organizations II and III as though they were total cost based measures will be discussed after the costing procedure is described.

Treating all TVE measures as the same gives us raw scores (measured, predicted or change) of the form:

$$\frac{\text{Actual Dollars}}{\text{Standard Dollars}} \times 100 = \text{TVE \%}$$

The relationship of this ratio to actual dollar costs is captured by the Standard Dollars. Multiplication of the TVE measure by the appropriate Standard Dollars for each organizational unit (cost center in our case) and division by 100 will yield the Actual Dollars involved. Since our raw score is predicted change in TVE, the product of this multiplication is predicted change in Actual Dollars. Table 3-8 shows the mean, standard deviation and selected percentile points of these Standard Dollars for one plant from Organization VI. The Standards are from all cost centers in that plant for 12 of the 14 months from July 1967 to August 1968, the end of the period during which the data in the present study were collected. In order to provide a range of estimates for the value of the Standard and consequently for the value of the predicted changes in TVE, the Standards at the 25th, 50th and 75th percentile of the distributions ($20,887, $55,715, and $144,150) will be used in the costing procedure.

Table 3-8

SELECTED PERCENTILES OF ENGINEERED DOLLAR STANDARDS FOR COST CENTERS FROM ORGANIZATION VI

Percentile	Dollar Standard
10	$ 11,218
20	19,915
25	20,887
30	24,748
40	41,511
50	55,715
60	79,741
70	125,940
75	144,150
80	180,520
90	457,000

Mean = $ 157,780

SD = 252,790

Table 3-9 shows the total predicted change in TVE for each Organization for each period. This is simply the sum of the predicted TVE changes for all cost centers in each Organization. Since the Standard Dollars to be applied to each cost center is the same, the organizational totals in Table 3-9 can be multiplied by the Standard Dollars to give the same result as would be obtained by multiplying the cost centers' predicted TVE changes by the Standard and summing the products to the organizational level. The result of this multiplication of the sums shown in Table 3-9 by the Standard Dollars above gives the predicted dollar change associated with TVE for each Organization. These figures are shown in Table 3-10. Again, negative quantities indicate predicted improvement or savings in organizational performance. This is true in subsequent tables for TVE and ABS.

It should be noted that although we have used three different estimates of the Standard to provide a range of dollar cost estimates, the Standard in each example is constant across all cost centers. This would not be the case if each cost center's standard were available. The Standard used in each example can be thought of as representing a weighted average of cost centers' Standards for organizations that have low, medium and high (25th percentile, 50th percentile, and 75th percentile, respectively) distributions of Standards. Because of the constant Standard in our example, we have summed the TVE measures and then costed the total to get a dollar total for each organization and period. In an actual application, however, differential Standards for the cost centers would have to be applied to the individual cost center TVE changes and only then would these costs be aggregated to the organizational level.

Beyond the assignment of a common Standard to all cost centers, the treatment of the TVE measures from Organizations II and III as though they were based on total costs rather than on labor costs influences our predicted cost savings. Figure 3-2 compares the results of multiplying the ratio of actual labor

Table 3-9

TOTAL PREDICTED CHANGE IN TVE[1] FOR EACH ORGANIZATION, BY PERIOD

	N	C	D	E	F	G	H	I
ORG II	15	-3.20	-3.66	-.91	3.40	1.29	4.87	.21
ORG III	11	-2.14	-4.30	-1.67	.35	.19	-.50	-.98
ORG IV	14	-3.86	-2.80	-2.22	-1.95	.15	.44	-1.28
ORG VI								
Plant 1	31	-.46	-.93	-.49	-.35	.30	.97	-.16
Plant 2	20	-.83	-1.19	-.81	-1.93	-.08	.15	-.73
Plant 3	36	2.27	-4.67	-2.84	-20.86	-1.33	6.36	.11

N = Number of Cost Centers. Number of Work Groups = 507

[1]Note: all figures are percentages

Table 3-10

DOLLAR VALUE OF PREDICTED CHANGE IN TVE FOR EACH ORGANIZATION, BY PERIOD

			N	C	D	E	F	G	H	I
$ STANDARD = $20,887	ORG II		15	-668	-764	-190	710	269	1017	44
	ORG III		11	-447	-898	-349	73	40	-104	-205
	ORG IV		14	-806	-585	-464	-407	33	92	-267
	ORG VI -	Plant 1	31	-96	-194	-102	-73	63	203	-33
		Plant 2	20	-173	-249	-169	-403	-17	31	-152
		Plant 3	36	474	-975	-593	-4357	-278	1328	23
			N	C	D	E	F	G	H	I
$ STANDARD = $55,715	ORG II		15	-1783	-2039	-507	1894	719	2713	117
	ORG III		11	-1192	-239	-930	195	106	-279	-546
	ORG IV		14	-2151	-1560	-1237	-1086	89	245	-713
	ORG VI -	Plant 1	31	-256	-518	-273	-195	167	540	-89
		Plant 2	20	-462	-663	-451	-1075	-45	84	-407
		Plant 3	36	1265	-2609	-1582	-11622	-741	3543	61
			N	C	D	E	F	G	H	I
$ STANDARD = $144,150	ORG II		15	-4613	-5276	-1312	4901	1860	7020	303
	ORG III		11	-3085	-6198	-2407	505	274	-721	-1413
	ORG IV		14	-5564	-4036	-3200	-2811	231	634	-1845
	ORG VI -	Plant 1	31	-663	-1341	-706	-505	432	1398	-231
		Plant 2	20	-1196	-1715	-1168	-2782	-115	259	-1052
		Plant 3	36	3272	-6732	-4094	-30070	-1917	9168	159

N = Number of Cost Centers

costs (ALC) to scheduled labor costs (SLC), by Standard Dollars (SD) (the denominator from TVE for Organizations IV and VI) to the result of multiplication by SLC. We are concerned with three possible situations: the labor cost ratio (ALC/SLC) is smaller than the dollar ratio (AD/SD), equal to, and larger than the dollar ratio. As shown in the first column, multiplication of the labor cost ratio by scheduled labor cost always yields a product, X, equal to actual labor cost which must be smaller than actual dollars. Column 2 shows that multiplication of the labor cost ratio by the Standard Dollar yields a product, X, that is in all cases larger than the actual labor cost and in two cases less than or equal to the actual dollars. Clearly in these two cases (cells 2 and 4) multiplication of the ALC/SLC ratio by SD yields a more accurate estimate of AD than does multiplication by SLC. In the third case (cell 6) the result of multiplying the labor ratio by SD is larger than ALC and AD. Whether AD is closer to ALC or to the product of the multiplication (X) will depend on the actual figures. Thus in at least two of the three possible situations, multiplication of the labor ratio by the standard dollars, as done in the present value attribution illustration, will increase the accuracy of the estimates of actual dollars. As was noted previously, the principle is the same whether we are estimating actual dollars, predicted actual dollars or predicted change in actual dollars.

ABSENCE

The ABS Criterion. The ABS measures from all four organizations are defined as ratios which are multiplied by 100 to yield a percentage (Pecorella & Bowers, 1977, p. 19). The measures are all of the general form:

$$\frac{\text{Number of Absences}}{\text{Possible Number of Absences}} \times 100 = \text{ABS\%}$$

For TVE, we divided by 100 and then costed the predicted change in TVE directly since the TVE measure was a ratio of dollar costs. For ABS we will divide by 100

Figure 3-2

EFFECT OF TREATMENT OF LABOR COST BASED TVE MEASURES AS STANDARD DOLLAR BASED TVE MEASURES ON ESTIMATES OF ACTUAL DOLLARS

$\frac{ALC}{SLC}$ MULTIPLIED BY:

Relation of $\frac{ALC}{SLC}$ to $\frac{AD}{SD}$:	SLC	SD
$\frac{ALC}{SLC} < \frac{AD}{SD}$	Cell 1 ALC = X < AD	Cell 2 ALC < X < AD
$\frac{ALC}{SLC} = \frac{AD}{SD}$	Cell 3 ALC = X < AD	Cell 4 ALC < X = AD
$\frac{ALC}{SLC} > \frac{AD}{SD}$	Cell 5 ALC = X < AD	Cell 6 ALC < AD < X

ALC = Actual Labor Costs

SLC = Scheduled Labor Costs

AD = Actual Dollars

SD = Standard Dollars

ALC < AD and SLC < SD since labor costs are only a portion of all dollar costs.

X = Product of $\frac{ALC}{SLC}$ and appropriate multiplier.

to eliminate the % and then multiply the predicted change in ABS by the denominator of the ABS measure to arrive at a predicted change in the number of absences. This change will then be costed using an estimate of the cost per absence.

Predicted Change in Person-days Absent. The ABS measures from Organizations I,[2] II, and III (Pecorella & Bowers, 1977) were computed as:

$$\frac{\text{Person-days Absent}}{\text{Person-days Scheduled}} \times 100 = \% \text{ ABS.}$$

The ABS measure from Organization VI was computed as:

$$\frac{\text{People Absent}}{\text{People in Cost Center}} \times 100 = \% \text{ ABS.}$$

Examination of the predicted changes in ABS for Organization VI shows them to be of the same order of magnitude as the predicted changes for Organizations I, II, and III. This indicates that predicted changes from all four Organizations can be treated as if they were of the form:[3]

$$\% \text{ Predicted Change in ABS} = \frac{\text{Predicted Change in Person-days Absent}}{\text{Person-days Scheduled}} \times 100$$

Thus division of the Predicted Change in ABS by 100 and subsequent multiplication by the Person-days Scheduled for a cost center will yield the Predicted Change in Person-days Absent for that cost center which can then be costed.

The number of Person-days Scheduled per cost center can be estimated by the product of the number of employees in the cost center and the number of work days in a month. The average number of employees in a cost center can be estimated for each Organization as the number of employees divided by the number of cost

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[2] In Organization I, the ABS measure was computed in essentially the same manner as in Organizations II and III, despite the fact that its verbal definition is different.

[3] This is the correct form for Organizations I, II, and III. For both substantive and statistical reasons the ABS measure for Organization VI ($\frac{\text{People Absent}}{\text{People in Cost Center}}$) is insensitive to changes in instances of Absence behavior over time. In order to compensate for this we have treated the predictions of change in ABS for Organization VI as though they were of the same form as in the orther organizations. Making this assumption produces predictions of changes in Person-days Absent which are of comparable or less magnitude than for other Organizations (seeTable 3-11). Thus we are confident we have compensated at least somewhat for the insensitivity of the measure without inflating our predictions of change.

centers. The figures in Table 3-1 were used in this calculation. The average number of workdays in a month is assumed to be twenty. Thus we have 308, 369, 2242, 428 and 629 as the average number of Person-days Scheduled per cost center per month for Organizations I, II, III and VI (plants 2 and 3) respectively. Since the Person-days Scheduled per month is constant across all cost centers in an organization, we can either multiply the predicted change in ABS for each cost center by the average number of Person-days Scheduled and aggregate the products to the organizational level or we can first aggregate the predicted change in ABS for each cost center to the organizational level and then multiply by the average number of Person-days Scheduled. Either procedure yields an estimate of the Predicted Change in Person-days Absent for each Organization. We followed the latter procedure. Table 3-11 shows the total change in ABS aggregated across cost centers for each Organization. Table 3-12 shows the predicted change in the number of Person-days Absent for each Organization computed from the total change in ABS for each Organization in Table 3-11 and the average number of Person-days Scheduled per cost center for each Organization. It is these figures (Table 3-12) which will be costed.

Before going on to establish the cost of these absence incidents, three items should be noted. First, in an actual implementation the denominator of the ABS measure would be known for each cost center for each month and would not have to be estimated as was done here using total number of employees, total number of cost centers and average number of work days in a month. Second, in an actual application, the number of Person-days Scheduled would vary across cost centers, causing the predicted change in Person-days Absent to be computed at the cost center level. Finally, it is possible that the cost of these absences would also vary across cost centers and therefore the costing procedure would also be done at the cost center level. Thus, it is likely that instead of aggregating predicted changes in

Table 3-11

TOTAL PREDICTED CHANGE IN ABS[1] FOR EACH ORGANIZATION, BY PERIOD

	N	C	D	E	F	G	H	I	J
ORG I	10	-11.06	3.97	-.71	-2.37	2.20	-2.03	-3.43	1.88
ORG II	15	.34	2.94	.62	.11	-3.85	-1.10	9.50	.22
ORG III	11	-1.92	.06	-1.30	-.65	.26	.05	.71	.15
ORG VI									
Plant 2	20	-8.44	8.56	2.02	-.47	.31	-6.01	3.57	-.93
Plant 3	36	1.79	5.73	2.96	-7.11	2.50	1.96	-10.16	4.81

N = Number of Cost Centers. Total Number of Work Groups = 373

[1]Note: all figures are percentages

Table 3-12

PREDICTED CHANGE IN PERSON-DAYS ABSENT FOR EACH ORGANIZATION, BY PERIOD

	N	C	D	E	F	G	H	I	J
ORG I	10	-3.3	12.2	-2.2	-7.3	6.8	-6.3	-10.6	5.8
ORG II	15	1.3	10.8	2.3	.4	-14.2	-4.1	35.1	.8
ORG III	11	-43.0	1.3	-29.1	-14.6	5.8	1.1	15.9	3.3
ORG VI									
Plant 2	20	-36.1	36.6	8.6	-2.0	1.3	-25.7	15.3	-4.0
Plant 3	36	11.3	36.0	18.6	-44.7	15.7	12.3	-63.9	30.3

N = Number of Cost Centers

ABS to the organizational level and computing both predicted changes in Person-days Absent and predicted cost changes for each Organization as is done here, one would perform all computations at the cost center level and aggregate only cost changes to the organizational level.

Relationship of Person-days Absent to Dollar Costs. There are no data available from any of our organizations regarding the cost of absence. However, Macy and Mirvis (1976) and Mirvis and Macy (1976) have estimated the cost of an incidence of absence at a southern manufacturing plant for three consecutive annual periods (1972-1973, 1973-1974, 1974-1975) and at a bank for the period January through December, 1973. The cost per incident at the manufacturer are reporter as $55.36, $53.15 and $62.49 respectively and the cost at the bank is reported as $98.22. It is clear that our measure of Person-days Absent is not identical to the definition of an absence incident used in calculating the above dollar figures. The measures are roughly comparable, however, and the dollar costs reported are useful for identifying a realistic range for the cost of absence in this illustration.

As with TVE, the cost of ABS will be estimated using three separate costs. The figures selected are $40.00, $80.00 and $120.00. Multiplication of the predicted change in number of absences shown in Table 3-12 by these three estimates results in the predicted cost changes shown in Table 3-13.

INFLUENCES ON THE COSTING RELATIONSHIP

There are a wide variety of factors which will influence the cost of a Person-day Absent and/or the size of an engineered Dollar Standard. These factors include the cost of wages and fringe benefits, policies for replacement of personnel, effect of absences on the production process, predictability of absences, nature of the production process, the cost of scrap or product which does not meet quality standards, and the effects of unplanned machine down time and inadequate

Table 3-13

DOLLAR VALUE OF PREDICTED CHANGE IN ABS FOR EACH ORGANIZATION, BY PERIOD

		N	C	D	E	F	G	H	I	J
Cost = $40	ORG I	10	-132	488	-88	-292	272	-252	-424	232
	ORG II	15	52	432	92	16	-568	-164	1404	32
	ORG III	11	-1720	52	-1164	-584	232	44	636	132
	ORG VI									
	Plant 2	20	-1444	1464	344	-80	52	-1028	612	-160
	Plant 3	30	452	1440	744	-1788	628	492	-2556	1212
		N	C	D	E	F	G	H	I	J
Cost = $80	ORG I	10	-264	976	-176	-584	544	-504	-848	464
	ORG II	15	104	864	184	32	-1136	-328	2808	64
	ORG III	11	-3440	104	-2328	-1168	464	88	1272	264
	ORG VI									
	Plant 2	20	-2888	2928	688	-160	104	-2056	[illegible]	-320
	Plant 3	36	904	2880	1488	-3576	1256	984	-5112	2424
		N	C	D	E	F	G	H	I	J
Cost = $120	ORG I	10	-396	1464	-264	-876	816	-756	-1272	696
	ORG II	15	156	1296	276	48	-1704	-492	4212	96
	ORG III	11	-5160	156	-3492	-1752	696	132	1908	396
	ORG VI									
	Plant 2	20	-4332	4392	1032	-240	156	-3084	1836	-480
	Plant 3	36	1356	4320	2232	-5364	1884	1476	-7668	3636

maintenance, to name only a few. The cost figures for the two criteria here were selected to represent a wide range of the conditions that actually exist. To the extent that any figure can be "typical" across the heterogeneous organizations in a modern society, the middle figures ($55,715 for TVE and $80 for ABS) are our "typical" figures.

Besides the variety of influences suggested by this list which influence the magnitude of the predicted costs, there are factors which affect primarily the accuracy and only subsequently the magnitude of the results. These factors concern the definition and measurement of our criteria and their relationship to costs. In Section II we considered some general influences of this sort. Here we will consider some of the influences which are particularly pertinent given the type of criterion measures we have used in the present study.

Effectiveness criteria are often defined in terms of a ratio, as has been done here. This raises some issues concerning the interpretation and accuracy of our predicted changes in cost which are most easily discussed in the context of a concrete example. Let us take a cost center where the state of the human organization has been measured at T_o and T_o', where $T_o' = T_o + 1$ year. The absence criterion for this cost center is defined as the ratio of Person-days Absent to Person-days Scheduled. To simplify the example, we assume that the cost of a Person-day Absent is constant from T_o to $T_o' + 1$ year, thus a change in the number of Person-days Absent is directly proportional to the change in cost and we discuss only the former. In this hypothetical cost center there were 500 Person-days Scheduled in month $T_o + k$ and there were 50 Person-days Absent, yeilding an ABS score of 10%. We wish to examine four possible situations regarding the prediction for month $T_o' + k$. These are shown in Figure 3-3. Cell 1 shows the situation where there is no change in ABS predicted and there are 500 Person-days Scheduled for month $T_o' + k$. Cell 2 shows no criterion change predicted but an increase in

Person-days Scheduled to 750. Cells 3 and 4 show a predicted decrease in ABS from 10% at $T_o + k$ to 5% at $T_o' + k$ with 500 and 750 Person-days Scheduled, respectively. The question is, what do our predictions about ABS, converted to number of Person-days Absent (or cost), mean in each of these four cases?

The results in Cell 1 are clear. Predicted change in ABS for $T_o' + k$ is zero and the predicted change in number of Person-days Absent is zero. In Cell 2, however, the situation is different. While there is no change in ABS predicted, and according to our procedure, no change predicted in the number of Person-days Absent, it is clear that an ABS rate of 10% with 750 Person-days scheduled, will mean 75 Person-days Absent, i.e., increase of 25 Person-days Absent. Yet we have predicted no change. The dilemma is an artificial one. We have predicted no change in Absence rate (ABS) due to changes in the state of the human organization. The projected increase in Person-days Absent is not due to a change in the state of the human organization but simply to an increase in the number of Person-days Scheduled. Thus in Cell 2 we are correct in attributing no change in the value of the human organization, even though the absolute number of Person-days Absent will increase from 50 to 75.

In Cells 3 and 4 we are faced with parallel situations. In Cell 3 the predicted change in ABS and Person-days Absent is -5% and -25 Person-days, respectively. This can be attributed to a change in the human organization. In Cell 4 the predicted change in ABS is also -5% but the change in Person-days Absent is -37.5. Here the improvement in Person-days Absent is attributable to a change in the human organization interacting with a change in the number of Person-days Scheduled. This is expected because of the multiplicative relationship implicit in the definition of our criterion. It also "makes sense" from two perspectives. First, the "larger" the human organization (either increased number of members, increased days scheduled or both) the greater the cost effects of changes in the

Figure 3-3

PREDICTED CHANGES IN PERSON-DAYS ABSENT FOR TWO VALUES OF PERSON-DAYS SCHEDULED AND TWO VALUES OF PREDICTED CHANGE IN ABS

		Person-days Scheduled For Month $T_o' + k$	
		500	750
ΔABS predicted for month $T_o' + k$	0%	Cell 1: No change predicted in Person-days absent	Cell 2: No change predicted in Person-days absent
	-5%	Cell 3: Decrease of 25 Person-days absent	Cell 4: Decrease of 37.5 Person-days absent

$$\text{ABS for month } T_o + k = \frac{50 \text{ Person-days absent}}{500 \text{ Person-days scheduled}} = 10\%$$

human organization. Second, all other conditions being equal, we would expect that it would require more time and energy invested to improve the human organization by a given amount when that organization is larger rather than smaller.

While our example has used the ABS measure, it applies equally well to the TVE measure when Standard Dollars is substituted for Person-days. By calculation of ABS and TVE as rates we deal with the problem of having different dollar standards and/or Person-days Scheduled across organizational units or across time for the same unit. This results in the appropriate predictions for Cells 2 and 4, as well as 1 and 3.

The situation shown in Cell 4 is typical of the predictions made in this study and of the conditions to be expected in an actual implementation, i.e., we can

expect some change in the denominator of our criterion measure from $T_o + k$ to $T_o' + k$. The hypothetical case above, the illustration in the present report and any practical application of the current value method, all assume that the predictor-criterion relationship is the same across the different values of the denominator from $T_o + k$ to $T_o' + k$. This is a particular case of the more general assumption that the relationship observed at $T_o + k$ can be appropriately applied at $T_o' + k$. This more general issue is discussed in Section IV. Because of the close relationship between the ratio nature of the criteria and the costing procedure, it is appropriate to discuss here two particular instances of this more general issue which may arise from the definition of the criterion as a ratio.

The predictive relationships are developed at $T_o + k$ for the population of work groups represented by those work groups actually used in the computation of the relationship. We expect the prediction equation to hold up when applied to work groups drawn from the same population. There are two mechanisms whereby changes in the denominators of the criterion measure may result in the application of the developed relationships to a different population. While discussed separately, it is unlikely that the differential effects of these two mechanisms would be clearly separable in an actual organization.

It is possible, even probable, that to a greater or lesser degree the denominator of the criterion represents a characteristic of the organizational unit for which the criterion score is calculated. Thus it seems likely that an organizational unit (work group, cost center, department) which has 500 Person-days Scheduled for a month is different from one that has 150 Person-days Scheduled for a month. This is not to say that the 350 Person-day difference is the critical difference between these units, but that it is likely that two units with a difference like this also have differences in the way the human organization relates to effectiveness. The same could be said for the denominator of the TVE measure.

To the extent that different denominators do reflect differences in work groups along critical diminsions and to the extent that the distribution of criterion denominators is different at $T_o' + k$ than it is at $T_o + k$ for the same units, we might expect that the relationships observed at $T_o + k$ will be different from those which will be observed at $T_o' + k$.

The second mechanism by which a change in criterion denominator may influence how well relationships observed at $T_o + k$ estimate those which will be observed at $T_o' + k$ has to do with the computation of criterion scores. The criterion scores at $T_o + k$ are a function of actual performance (numerator) and standard performance (denominator). To the extent that the denominators at $T_o' + k$ are extreme, relative to their values at $T_o + k$ we can expect the criterion scores which will be observed at $T_o' + k$ to be outside the range of scores for which the predictor criterion relation at $T_o + k$ was developed. Thus we would be attenpting to predict a population of scores at $T_o' + k$ that is different from the population of scores at $T_o + k$. To the extent that this happens, we should be alert to possible changes in the predictor criterion relationship from $T_o + k$ to $T_o' + k$.

There are two points that should be considered in relation to these two mechanisms. First, it seems likely the cost center "standards" (i.e. criterion denominators) are more susceptible to radical changes than are work group standards. Thus, these mechanisms are potentially more problematic for applications, as in the present example, where criterion definition and valuation take place at the cost center level rather than at the work group level. Secondly, change in the criterion denominator is only one of numerous factors which have the potential to decrease the accuracy of our predictions. The more pressing question is: "Can we still predict?" and if so, what is it that we are predicting? This question, along with other potential influences on the predictor-criterion relationship will be discussed in Section IV.

5. Period to Month Conversion

Thus far, the value attribution process has been conducted using performance periods. The discounting process requires that the timing of cost changes be expressed in time units of known real duration. Thus predictions made for performance periods must be converted to performance months.

Performance periods were originally defined separately for each criterion and organization so that all monthly performance scores assigned to a perormance period were 1) sequential and 2) more similar to each other than to criterion scores for months not in the period. The criterion scores for each period were computed as the arithmetic averages of the criterion scores for each month in the period. Implicit in this procedure is the notion that performance score variance among months within a period reflects little more than error. It follows that the S.O.O.-criterion relationship is essentially the same for all months in a period and therefore that the change in performance predicted for a period is the same change as is predicted for each of the months in that period.

In order to assign changes predicted for particular periods to particular months, it is necessary to know which months compose which periods. This was determined using the notion of equivalent periods described at the start of Section III. Predictions made for equivalent periods are assigned to the months that are included in that period. The months in each equivalent period vary across Organizations. Tables 3-14 and 3-15 present the matrices whereby predicted changes in TVE and ABS made for equivalent performance periods are converted to predicted changes in TVE and ABS for months $T_o' + 1$ through $T_o' + 12$, according to the above procedure.

This procedure defines the period to months conversion for each criterion-month-organization combination where criterion data was originally collected. Lack of criterion data for certain months in certain organizations, however, means

some of the cells in the conversion table are unable to be completed using this process. These are indicated by an asterisk (*) in Tables 3-14 and 3-15. These cells were completed by assigning the months involved to the periods which would produce the most consistent overall pattern of period-month relationships.

Application of this period to month conversion scheme to the value of predicted changes in TVE and ABS for each period (Tables 3-10 and 3-13) produces the dollar value of the predicted changes for months $T_o' + 1$ through $T_o' + 12$, as shown in Tables 3-16 and 3-17. It is these values which will be discounted and capitalized in the final step of the value attribution process.

Finally, it will be recalled that at the start of this section the procedure for selection of work groups to be used in this illustration was described. This procedure resulted in the prediction of criterion change for work groups and Organizations in periods where the Organization was not represented in the computation of the prediction equation. In Tables 3-14 and 3-15, the Organization-month cells labeled with an asterisk are those where the only prediction available is that made by an equation where the Organization concerned was not represented in the data. The predictions made for these Organization-period combinations are most probably less accurate than those made for Organization-period combinations where the Organization was represented in the calculation of the prediction equation. The period to month conversion scheme described here maximizes the use of the latter, more accurate predictions and minimizes the use of the former, less accurate predictions. These less accurate predictions are included to provide a complete set of predictions for 12 months for each Organization which will be capitalized in the final step of the Value Attribution. However, our confidence in the accuracy of the predictions for the cells labeled by an * is considerably less than for the remaining cells.

Table 3-14

CONVERSION OF TVE PERFORMANCE PERIODS TO MONTHS

Month: T_o' +	1	2	3	4	5	6	7	8	9	10	11	12
ORG II	D	D	D	E	E	E	E	E	G*	I*	I*	I*
ORG III	D*	D*	D	D	E	E	E*	F*	I	I	I	I
ORG IV	D	D	D	D	D	D	E*	F	G*	I*	I*	I*
ORG VI[1]												
Plant 1	C	D	D	D	E	E	E	F	G	H	I	I
Plant 2	D	D	D	D	E	E	E	E	I	I	I	I
Plant 3	D	D	E	E	E	F	F	F	I	I	I	I[2]

*Lack of performance data for this month--organization combination precluded definition of an equivalent period. This period assigned on the basis of consistency with the overall pattern of month-period relationships.

[1]Performance periods were defined individually and differently for different plants in this organization.

[2]Reassigned from Period J.

Table 3-15

CONVERSION OF ABS PERFORMANCE PERIODS TO MONTHS

Months T_o^1 +	1	2	3	4	5	6	7	8	9	10	11	12
ORG I	D	E	E	F	G	G	G	G	H	H	H	H
ORG II[1]	D	D/E	D/E	D/E	F	G	G	H*	H*	I*	I*	J*
ORG III	D*	D*	E	E	F	G	G*	H*	H	H	I	J
ORG VI[2]	C	C	D*	D*	E	G*	G*	H*	H*	I*	I*	J*

*Lack of performance data for this month--organization combination precluded definition of an equivalent period. This period assigned on the basis of consistency with the overall pattern of month-period relationships.

[1]Periods were defined identically for all four plants in this Organization with the exception of Periods D and E. Period D ends at Month T_o^1+4 for Plants 1 and 2, at Month T_o^1+2 for plant 3 and at Month T_o^1+1 for plant 4. Period E follows D in these two plants.

[2]Periods defined identically for plants 2 and 3.

6. Capitalization and Discounting

As discussed in Section II, future income may be discounted to present value to account for the fact that income to be received in the future is of less value (smaller absolute magnitude) than the same income were it received today. This is because the latter may be invested at a given interest rate and will thus have more value in the future. Capitalization is a means of determining the investment value of a property by determining the size of an investment required to produce the income to be received from the property. Since it is the present values that are capitalized, we will first discount the anticipated income shown in Tables 3-16 and 3-17 to their present values. The resultant present values will then be capitalized.

DISCOUNTING

The key factors in discounting are 1) the timing of anticipated income and 2) the interest rate. Estimating the timing of the cost changes resulting from changes in the human organization is an implicit part of the prediction process. Since we will discount to T_o', the month k after T_o' in which a cost change is predicted to occur is equal to the number of months over which the cost change must be discounted. The interest rate to be used may be selected according to any of several criteria or a combination of them. The average cost of funds for a loan of similar size and duration might be one criteria. The interest available if the funds were invested might also be used. In an FPTI implementation, the actual situation of the organization would determine the rate to be used. Our desire here is to provide an illustration that is both understandable and realistic. Too low an interest rate will result in the current value being higher than otherwise, too high a rate will have the opposite effect. Since our time units are in months, and because it provides a mid-range annual interest rate, we have selected a monthly interest

Table 3-16

DOLLAR VALUE OF PREDICTED CHANGE IN TVE BY MONTH AND ORGANIZATION

	Month T_o' +	1	2	3	4	5	6	7	8	9	10	11	12
$ STANDARD = 20,887	ORG II	-764	-764	-764	-190	-190	-190	-190	-190	269	44	44	44
	ORG III	-898	-898	-898	-898	-349	-349	-349	73	-205	-205	-205	-205
	ORG IV	-585	-585	-585	-585	-585	-585	-464	-407	33	-267	-267	-267
	ORG VI - Plant 1	-96	-194	-194	-194	-102	-102	-102	-102	-33	-33	-33	-33
	Plant 2	-249	-249	-249	-249	-169	-169	-169	-169	-152	-152	-152	-152
	Plant 3	-975	-975	-593	-593	-593	-435	-435	-435	23	23	23	23

	Month T_o' +	1	2	3	4	5	6	7	8	9	10	11	12
$ STANDARD = 55,715	ORG II	-2039	-2039	-2039	-507	-507	-507	-507	-507	719	117	117	117
	ORG III	-2396	-2396	-2396	-2396	-930	-930	-930	195	-546	-546	-546	-546
	ORG IV	-1560	-1560	-1560	-1560	-1560	-1560	-1237	-1086	89	-713	-713	-713
	ORG VI - Plant 1	-256	-518	-518	-518	-273	-273	-273	-273	-89	-89	-89	-89
	Plant 2	-663	-663	-663	-663	-451	-451	-451	-451	-407	-407	-407	-407
	Plant 3	-2602	-2602	-1582	-1582	-1582	-11622	-11622	-11622	61	61	61	61

	Month T_o' +	1	2	3	4	5	6	7	8	9	10	11	12
$ STANDARD = 144,150	ORG II	-5276	-5276	-5276	-1312	-1312	-1312	-1312	-1312	1860	303	303	303
	ORG III	-6198	-6198	-6198	-6198	-2407	-2407	-2407	505	-1413	-1413	-1413	-1413
	ORG IV	-4036	-4036	-4036	-4036	-4036	-4036	-3200	-2811	231	-185	-185	-185
	ORG VI - Plant 1	-662	-1341	-1341	-1341	-706	-706	-706	-505	432	139	-231	-231
	Plant 2	-1715	-1715	-1715	-1715	-1168	-1168	-1168	-1168	-1052	-1052	-1052	-1052
	Plant 3	-6732	-6732	-4094	-4094	-4094	-30070	-30070	-30070	159	159	159	159

Table 3-17

DOLLAR VALUE OF PREDICTED CHANGE IN ABS BY MONTH AND ORGANIZATION

		1	2	3	4	5	6	7	8	9	10	11	12
Cost = $40	ORG I	488	-88	-88	-292	272	272	272	272	-252	-252	-252	-252
	ORG II	432	347*	262*	262*	16	-568	-568	-164	-164	1404	1404	32
	ORG III	52	52	-1164	-1164	-584	232	232	44	44	44	636	132
	ORG IV												
	Plant 2	-1444	-1444	1464	1464	344	52	52	-1028	-1028	612	612	-160
	Plant 3	452	452	1440	1440	744	628	628	492	492	-2556	-2556	1212
Cost = $80	ORG I	976	-176	-176	-584	544	544	544	544	-504	-504	-504	-504
	ORG II	864	694*	524*	524*	32	-1136	-1136	-328	-328	2808	2808	64
	ORG III	104	104	-2328	-2328	-1168	464	464	88	88	88	1272	264
	ORG VI												
	Plant 2	-2888	-2888	2928	2928	688	104	104	-2056	-2056	1224	1224	-320
	Plant 3	904	904	2880	2880	1488	1256	1256	984	984	-5112	-5112	2424
Cost = $120	ORG I	1464	-264	-264	-876	816	816	816	816	-756	-756	-756	-756
	ORG II	1296	1041*	786*	786*	48	-1704	-1704	-492	-492	4212	4212	96
	ORG III	156	156	-3492	-3492	-1752	696	696	132	132	1[illegible]2	1908	396
	ORG VI												
	Plant 2	-4332	-4332	4392	4392	1032	156	156	-3084	-3084	1836	1836	-480
	Plant 3	1356	1356	4320	4320	2232	1884	1884	1476	1476	-7668	-7668	3636

*Calculated as a weighted combination of periods D and E. Weights assigned equal to the proportion of Plants in each period, D and E. Month 2 = .75 D + .25 E; Month 3 = Month 4 = .5 D + .5 E.

rate of 1% for our calculations. Compounded monthly, this is equal to an annual rate of 12.81%.

Using the discounting or present value formula, equation (2-3), we have:

$$PV = \sum_{k=1}^{12} \frac{PC_k}{(1+i)^k}$$

PC is the predicted cost change in each cell of Tables (3-15) and (3-16)

k is the month for the predicted cost change.

i = .01.

Tables 3-18 and 3-19 show the Present Value of predicted costs changes for each month. Tables 3-20 and 3-21 shows the sum of these Present Values for each Organization and for our composite organization. In addition, the present value of the predicted changes for each Organization is shown on a per cost center, per work group and per person basis. These latter figures are provided to place the results in the context of the various measures of size of the Organizations. The numbers of cost centers, work groups and individuals used in these calculations were taken from Table 3-1.

CAPITALIZATION

There are three key quantities in capitalization. The first is the amount of income to be capitalized. This is provided by the Present Values from Tables 3-20 and 3-21. The second is the rate of return. The rate of return to be used in the present study was taken from the 1971 FORTUNE 500 listing for each of the five Organizations. The net income as a percent of stockholder equity was doubled to estimate the before tax rate of return. The average of this figure across all five Organizations was used as the rate of return for capitalization of the Present Values. This average rate of return is 16%. The final quantity necessary for capitalization is an estimation of the duration of the anticipated stream of income. As discussed in Section II, the duration of changes in the human organization is at

Table 3-18

PRESENT VALUE OF CHANGES IN TVE, DISCOUNTED AT 1% PER MONTH

		1	2	3	4	5	6	7	8	9	10	11	12
$ STANDARD = $20,897	ORG II	-757	-749	-742	-183	-181	-179	-177	-176	246	40	39	39
	ORG III	-889	-880	-872	-863	-332	-329	-325	68	-187	-185	-183	-182
	ORG IV	-579	-573	-568	-562	-556	-551	-432	-376	31	-242	-240	-237
	ORG VI - Plant 1	-95	-190	-189	-187	-97	-96	-95	-95	-31	-30	-30	-30
	Plant 2	-246	-244	-241	-239	-161	-159	-158	-156	-139	-138	-137	-135
	Plant 3	-966	-956	-576	-570	-564	-410	-406	-4024	21	21	21	20

		1	2	3	4	5	6	7	8	9	10	11	12
$ STANDARD = $55,715	ORG II	-2019	-1999	-1979	-487	-483	-478	-473	-468	665	106	105	104
	ORG III	-2372	-2349	-2325	-2302	-885	-877	-868	180	-499	-494	-489	-485
	ORG IV	-1545	-1529	-1514	-1499	-1484	-1470	-1154	-1003	82	-646	-639	-633
	ORG VI - Plant 1	-254	-508	-503	-498	-260	-257	-255	-252	-82	-81	-80	-79
	Plant 2	-656	-650	-644	-637	-429	-425	-421	-417	-372	-368	-365	-361
	Plant 3	-2576	-2551	-1536	-4980	-1506	-10949	10840	-10733	56	55	54	54

		1	2	3	4	5	6	7	8	9	10	11	12
$ STANDARD = $144,150	ORG II	-5226	-5172	-5121	-1261	-1248	-1236	-1224	-1211	1709	274	271	264
	ORG III	-6137	-6076	-6016	-5957	2290	-2268	-2245	4660	-129	-1279	-1266	-1254
	ORG IV	-3996	-3957	-3918	-3879	-3840	-3802	-2985	-2596	211	-167	-165	-164
	ORG VI - Plant 1	-657	-1314	-130	-1288	-672	-665	-659	-466	-395	-1266	-207	-205
	Plant 2	-1698	-1682	-1665	-1648	-1111	-1100	-1089	-1078	-962	-953	-943	-934
	Plant 3	-6665	-6599	-3973	-3934	-3895	-2832	-28047	-27769	145	144	142	141

Table 3-19

PRESENT VALUE OF CHANGES IN ABS, DISCOUNTED AT 1% PER MONTH

		1	2	3	4	5	6	7	8	9	10	11	12
Cost = $40	ORG I	483	-86	-85	-281	259	256	254	251	-230	-228	-226	-224
	ORG II	428	340	254	252	15	-535	-530	-151	-150	1271	1258	28
	ORG III	51	51	-1130	-1119	-556	219	216	41	40	40	570	117
	ORG VI												
	Plant 2	-1430	-1416	1421	1407	327	49	49	-949	-940	554	549	-142
	Plant 3	448	443	1398	1384	708	592	586	454	450	-2314	-2291	1076
		1	2	3	4	5	6	7	8	9	10	11	12
Cost = $80	ORG I	966	-173	-171	-561	518	512	507	502	-461	-456	-452	-447
	ORG II	855	680	509	504	30	-1070	-1060	-303	-300	2545	2517	57
	ORG III	103	102	-2260	-2237	-1111	437	433	81	80	80	1140	234
	ORG VI												
	Plant 2	-2859	-2831	2842	2814	655	98	97	-1899	-1880	1108	1097	-284
	Plant 3	895	886	2795	2768	1416	1183	1171	909	900	-4628	-4582	2151
		1	2	3	4	5	6	7	8	9	10	11	12
Cost = $120	ORG I	1450	-259	-256	-842	776	769	761	754	-691	-685	-678	-671
	ORG II	1283	1020	763	755	46	-1605	-1589	-454	-450	3813	3775	85
	ORG III	154	153	-3389	-3356	-1667	656	649	122	121	119	1710	351
	ORG VI												
	Plant 2	-4289	-4247	4263	4221	982	147	146	-2848	-2820	1662	1646	-426
	Plant 3	1343	1329	4193	4151	2124	1775	1757	1363	1350	-6942	-6873	3227

Table 3-20

PRESENT VALUE OF PREDICTED CHANGES IN TVE

	Total[1,2]	Per Cost Center	Per Work Group	Per Man
Dollar Standard = $20,887				
ORG II	-2780	-185	-45	-10
ORG III	-5160	-469	-3[illegible]	-4
ORG IV	-4886	-349	-47	-5
ORG VI				
Plant 1	-1165	-38	-24	-[illegible]
Plant 2	-2154	-108	-57	-5
Plant 3	-12141	-337	-132	-11
Composite:	-28286	-223	-56	-6
Dollar Standard = $55,715				
ORG II	-7414	-494	-120	-27
ORG III	-13765	-1251	-85	-11
ORG IV	-13034	-931	-125	-13
ORG VI				
Plant 1	-3107	-100	-63	-7
Plant 2	-5745	-287	-151	-13
Plant 3	-32387	-900	-352	-29
Composite:	-75452	-594	-149	-17
Dollar Standard = $144,150				
ORG II	-19181	-1279	-309	-69
ORG III	-35614	-3238	-220	-29
ORG IV	-33723	-2409	-324	-34
ORG VI				
Plant 1	-8071	-260	-165	-19
Plant 2	-14864	-743	-391	-35
Plant 3	-83793	-2328	-911	-74
Composite:	-195246	-1537	-385	-43

[1] Total of Discounted Values in Table 3-18

[2] All figures rounded to nearest dollar

Table 3-21

PRESENT VALUE OF PREDICTED CHANGES IN ABS

	Total[1,2]	Per Cost Center	Per Work Group	Per Man
Cost = $40				
ORG I	143	14	8	1
ORG II	2480	165	40	9
ORG III	-1460	-133	-9	-1
ORG VI				
Plant 2	-1521	-26	-14	-1
Plant 3	2934	82	32	3
Composite:	3576	39	10	1
Cost = $80				
ORG I	284	28	15	2
ORG II	4961	331	80	18
ORG III	-2918	-265	-18	-2
ORG VI				
Plant 2	-1042	-52	-27	-2
Plant 3	5864	163	64	5
Composite:	7149	78	19	2
Cost = $120				
ORG I	426	43	22	3
ORG II	7442	496	120	27
ORG III	-4377	-397	-27	-4
ORG VI				
Plant 2	-1563	-78	-41	-4
Plant 3	8796	244	96	8
Composite:	10724	117	29	3

[1] Total of Discounted Values in Table 3-19

[2] All figures rounded to nearest dollar

present unknown. We will assume that these changes will continue, as calculated for the first year, in perpetuity.

The actual capitalization consists of dividing the present values in Tables 3-20 and 3-21 by the rate of return. The result of this calculation is shown in Table 3-22.[4] The sign of the capitalized values in Table 3-22 has been reversed from previous tables so that a positive value indicates an increase in the investment value and a negative value indicates a decrease in investment value of the organization.

Summary

The results of the value attribution demonstration do not correspond to what might be expected for any single "real" organization. They are, however, what we might reasonably expect for an organization with the human and technological characteristics of our "composite" organization. While there is little point in a detailed discussion of the results of each step of the demonstration, certain features are notable. All the present values associated with TVE (Table 3-20) are in the expected direction while ABS (Table 3-21) has mixed results. This is unexpected and will be discussed further in Section V. The absolute magnitudes of the TVE values are uniformly larger than for ABS, although for Organization II the difference is slight. This is due to two factors. One is the larger multiplier used for the valuation of the TVE changes. The second factor is the greater number of positive predictions for ABS relative to TVE (Tables 3-16 and 3-17) which, when summed across periods results in smaller absolute magnitudes in Table 3-21. This

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[4]Customary accounting practice is to capitalize only income which will occur beyond the current fiscal year. Expenses or income occurring during the current fiscal year are treated as current income or current expenses. In this example no attempt has been made to simulate a portion of the anticipated income occurring during the current fiscal year. Rather, for our purposes, all anticipated income has been capitalized.

Table 3-22

CAPITALIZED PRESENT VALUES FOR TVE AND ABS

	TVE		
Dollar Standard:	$20,887	$55,715	$144,150
ORG II	17375	46338	119881
ORG III	32250	86031	222588
ORG IV	30538	81462	210769
ORG VI			
Plant 1	7281	19419	50444
Plant 2	13463	35906	92900
Plant 3	75881	202419	521831
Composite:	176788	471575	1220288
	ABS		
Cost:	$40	$80	$120
ORG I	-894	-1775	-2663
ORG II	-15580	-31006	-46513
ORG III	9125	18238	27356
ORG VI			
Plant 2	3256	6513	9769
Plant 3	-18338	-36650	-54975
Composite:	-22350	-44681	-67025

Note: All signs in this table are reversed from previous tables. Positive values show capitalization of an asset. Negative values show capitalized value of a liability.

second factor can be easily seen by comparing Tables 3-16 and 3-17. In Table 3-16 only 14% of the predictions for TVE are positive. In Table 3-17, 65% of the predictions for ABS are positive. When summing across months to arrive at the current values, positive and negative predictions tend to cancel each other out, thus producing smaller absolute totals.

A third feature of the ABS and TVE results arises from the definition of the measures and their valuation. The costs represented for each criteria are not independent of costs for the other criteria. For example, some of the change in TVE costs may be due to changes in absenteeism. Because of this, TVE and ABS costs may not simply be added together to arrive at a total for each organization.

IV. COMPARISON OF RELATIONSHIPS ACROSS TIME

Inplicit in the current-value approach to human resources accounting is the assumption that there is not only a relationship between the current state of an organization's human system and the organization's current effectiveness, but there is also a predictive aspect, i.e. a relationship between the current state of the human system and future effectiveness. The existence of both types of relationships has been demonstrated in this study by Pecorella and Bowers (1977). In using these predictive relationships, we make assumptions about their stability with regard to a variety of factors. This section will examine some of these factors, notably time, and discuss their implications for the FPTI methodology.

Time Lag Effect

One significant source of change in the predictor-criterion relationship is the time between measurements of the human system (predictors) and of organizational effectiveness (criterion). This is the time-lag effect discussed by Pecorella and Bowers (1977). Their results show the strength of the relationship changing over time with the strongest relationships occurring for effectiveness measured immediately following the measurement of the social system and at about 18 months later. The strongest of these two relationships is at the 18 month point. The existence of the time lag is consistent with the theory on which the FPTI methodology is based (Pecorella and Bowers, 1976a).

While it is the existence of the predictor to future performance relationship which underlies the FPTI methodology, the existence of the time lag pattern raises methodological issues. Clearly the time since measurement of the human system should be incorporated in the prediction procedure. One alternative is to enter a time variable into the prediction equation. In particular, such a model may look like $Y_k = B_0 + \underline{B}\,\underline{X} + \gamma(k)$ where $\underline{X}$ is the vector of S.O.C. scores and $\gamma(k)$ is a

function of k, k being the time since measurement of the human system, and Y_k is the performance at time $T_o + k$. Another alternative, used in this study (Davenport et al., 1977), is to construct separate prediction equations for each time period (i.e. each value of k) subsequent to the human system measurement.

Organizational Effects

A second source of variation in the relationship is the organization. The types of products, the nature of the work force used to produce them, and the resulting interdependence patterns of individuals and groups may result in differences in the performance-human system relationship. In fact, within a medium to large organization, the relationship may change across divisions or job types. In the present study, the reported relationships are quite likely underestimated as different organizations were grouped together in order to provide sufficient data and adequate sample sizes.

Variation in the predictor-criterion relationship across organizational units may be accounted for by developing different prediction equations for the different units. This requires an adequate number of work groups from each unit, a condition which may not always be easy to achieve. An alternative is to include additional predictor(s) as cross product(s) of the variable(s) of interest and appropriate S.O.O. variable(s). A somewhat less difficult situation occurs when certain organizational characteristics add to the explanatory power of the S.O.O. predictors, within the constraints of the linear additive regression model. Davenport et al. (1977) provide two examples of these variables: organizational size and a measure of capital intensity (defined as the ratio of total dollar assets to the number of employees). In using such variables, however, it is important that value attributed to future performance predictions reflect changes in the human system, and not in the additional variables.

Variation Across Predictor Measurements

Both of the above sources of variation in the predictor-criterion relationship are relevant to just a single measurement of the human system. The prediction of future effectiveness, however, requires two measurements of the human organization. The first measurement, together with subsequent measures of effectiveness, is used to define the relationship between the two sets of variables. The second measurement is used to make the predictions based on the previously defined relationship. This raises the possibility that the relationship identified for a given value of lag time relative to the initial measurement will not be the same as the relationship for the same lag time relative to the second measurement. This type of variation in the relationship, referred to as variation across predictor measurements, is the primary concern of this Section.

Our conception of organizations as open, living systems gives us some indication as to factors which might produce this variation across predictor measurements. The organization's environment is one. A sudden downturn in general economic conditions could change the strength and nature of the relationship between the state of the human organization and effectiveness. Seasonal fluctuations in product demand or employee attendance might influence the related effectiveness measures with little or no change in the predictors. To the extent that these external conditions are known, one may account for them. An example pertinent to the present study is the use of engineered performance standards to define criterion scores. These standards are defined annually and are based on past performance and anticipated demand for the coming year. Obviously, demand can be predicted more accurately for the first of 12 months than for the last. Thus our criterion scores will be less accurate and the strength of the relationship will decrease somewhat at the end of the annual period for which

standards are computed. If the predictors are consistently measured at the same time relative to the definition of the standard, however, this influence will be constant across predictor measurements. The same approach can be taken with regard to other seasonal fluctuations, whether they arise from sources internal or external to the system.

Of more direct interest here, however, are changes in the relationship across predictor measurements which arise from the internal dynamics of organizations. Given a relatively stable environment, organizations can and do change because of factors internal to the system. Changes in personnel, particularly at the upper levels, can have a profound impact on the system. Another potentially powerful influence would be the implementation of planned, systemic, organizational change activities. It seems clear that activities which strongly impact the human system have a high probability of impacting the relationship of this human system to the organization's effectiveness. For example, if in between measurements of the human system, communication networks were altered to radically increase the task and socio-emotional information available at all levels, it is possible that the lag time in the responsiveness of the total organization to the human system would be decreased. Thus our strongest relationship might be observed at 12 months lag time instead of at 18 months. Clearly, use of the relationships developed under the old communication system would not accurately reflect the relationships under the new system. Other examples could be given but the problem described remains the same. There are numerous factors, internal and external to the organization, which can change the nature of the predictor-criterion relationship so that the relationship originally developed does not reflect the relationship that will exist during the period for which we are predicting.

It is possible to artificially divide these different sources of variation across predictor measurements into two categories: those which can be identified and

whose influence on the relationship can be accounted for in some predictable manner, and those which, while real, are unaccounted for and/or unplanned. It is clear that research may move some factors from the latter category to the former, but it is unlikely that this will be the case for all possible influences. Whether or not we have identified any of these influences, the very fact that we are predicting means we will never know how accurate our predictions are until after the event predicted has occurred and an evaluation can be made. Clearly this does not mean that we should not predict. It does mean that we should examine past predictions to develop means of making better predictions. In particula it would be appropriate for an organization applying the FPTI methodology to human resources accounting to continually update their prediction equations. One model for this activity would involve the following steps: 1) regular collection of performance data; 2) periodic (eg. annual) measurement of the human system; and 3) the inclusion of previously collected predictor and criterion data together with the current data in the pool from which the prediction equations for the future will be calculated. Additionally, as an organization's data set grows, there would be more opportunity to examine the ability to improve prediction through the use of additional variables. Thus, monitoring the predictor-criterion relationships over time would allow an organization to more fully understand the effect of external and internal influences on its performance, on its human resources and on their relationship.

Analysis of Variation Across Predictor Measurements

Introduction

The data from the present study present us with an opportunity to examine the assumptions made in the value attribution regarding the change or lack of change in the predictor-criterion relationship across predictor measurements.

Before describing the approach to be used in examining the assumptions, however, it is appropriate to mention several constraints on the investigation which exist for both statistical and substantive reasons.

In order to predict future performance changes using observed predictor-criterion relationships, we assumed that there was no change in the relationship over time. The statistical constraints on examining this assumption arise from three sources. First, examination of the assumption involves comparing the predictor-criterion relationships developed at $T_o + k$ to those that exist at $T_o' + k$. Only one Organization (VI) has criterion data (TVE) available for enough consecutive measurements (2 years) to adequately compare the relationships at $T_o + k$ and $T_o' + k$. Thus we have a relatively small number of work groups which, more importantly, have limited criterion variance due to imputation. Second, it was suggested above that prediction would be improved as the equations were based on an increasing number of observations. In this case, the equations to be examined are based on observation at one point in time only. Finally, our technique requires comparable periods of time subsequent to T_o and T_o'. Examination of the period definitions for Organization VI (Pecorella and Bowers, 1977, p. 22) reveals the difficulty in identifying comparable performance periods. Therefore we shall use monthly TVE data in the examination of the across time variations in predictor-criterion relationships. This most probably reduces the reliability of the criterion measures, decreasing the strength of the relationships to be examined.

The substantive constraints on our investigation arise from two sources. First, to provide an adequate N for the computation of predictor-criterion relationships we will combine data from two different plants of Organization VI. As noted by Pecorella and Bowers (1976b), the plants in Organization VI differ enough in terms of technical and social features to be treated as different organizations, instead of being combined into one Organization as were the four

plants from Organization II. While this same procedure has been used throughout the study due to limitations on the amount of data available, we have noted that we suspect there is a resultant decrease in the accuracy of our predictor-criterion relationships as applied to any individual organization.

The second substantive issue concerns the fact that during the time the data were collected, all plants in Organization VI were participating in planned change activities focusing on the human systems. To the extent that the change activities succeeded, we might expect change in the way the human organization relates to effectiveness. An evaluation of these change activities, conducted prior to and independently of the present research, indicated that they had a significant positive influence in one of our two plants and had at best a marginal effect in the other. This not only increases the difference between the two plants whose data we are combining, but more importantly, leads us to expect some change in the predictor-criterion relationship from $T_o + k$ to $T_o' + k$. Clearly this is something to be considered in an examination of the assumption that there was no change in this relationship.

Statistical Analysis

Two procedures are used to examine the variation of predictor-criterion relationships across time. The first technique tests the equivalency of the beta coefficients for comparable times subsequent to the two S.O.O. administrations. The second procedure examines the agreement between predicted and actual criterion scores.

Notationally, the predictor-criterion relationship is modeled by $Y_k = B_0 + \underline{B}_k\underline{X}$ and $Y'_k = B'_0 + \underline{B}'_k\underline{X}'$, where the subscript k denotes the time since measurement of the human system; $\underline{X}$ and $\underline{X}'$ are the human system scores at time T_o and T_o', and $\underline{B}_k$ and $\underline{B}'_k$ are the vectors of beta-coefficients. The assumption of common relationships at equal times since predictor measurement is then given by

$\underline{B}_k = \underline{B}'_k$, for each k. The first procedure is to test the hypotheses, $H_o : \underline{B}_k = \underline{B}_k$, k = 1,2,...,12.

The procedure for testing $H_o: B_k = B'_k$ for any k is given by Zar (1974, p. 273). One first combines the T_o and T_o' data, computes the residual sum of squares (SS_{12}), then deletes the T_o' data, computes the residual sum of squares for T_o alone (SS_1), and forms an F-ratio:

$$F_{(14,DF_{12})} = \frac{\frac{SS_1 - SS_{12}}{(13+1)(1)}}{\frac{SS_{12}}{DF_{12}}}$$

where DF_{12} is the residual degrees of freedom of the combined data set. The ratio has an F distribution with (14, DF_{12}) degrees of freedom.

This F test, like other statistical tests, allows us to determine the probability of falsely rejecting H_o (alpha level). Our interest, however, lies in accepting H_o. Given this orientation, the probability of detecting a false H_o, i.e. the power of the test, is of interest to us. Unfortunately, Zar (1974) gives no technique for computing the power of the above test. We suspect, however, that the power of this test as conducted here is at best moderate. This suspicion is due to the relatively large observed standard errors of the b's which are being tested for equality. This increased variance of the b's means that it will be more difficult to detect true differences between them. Power increases as alpha increases; therefore we set alpha at a liberal 0.1. Given this alpha, we expect to reject H_o for at least one of the 12 tests of H_o when the H_o are true.

The result of the tests of H_o for each pair of monthly regression equations are given in Table 4-1. Of the 12 H_o's tested, 3 (months 1 & 13; 5 & 17; 9 & 21) can be rejected at alpha = 0.1. On the other hand, the F statistic is less than 1.0 for 3 of the H_o (months 3 & 15; 7 & 19; 10 & 22). Thus: 1) we can reject 3 of the H_o's

(at a liberal alpha = 0.1); and 2) we fail to reject the remaining H_o's, three of which we would be unable to reject even at alpha = 0.5. While these results tend to support our assumption that $\underline{B}_k = \underline{B}'_k$ the suspected lack of power of the test lessens our confidence in this support. The most appropriate conclusion from these tests is that they do not invalidate our assumption.

Table 4-1

Tests of $H_o : \underline{B}_k = \underline{B}'_k$

Months	Multiple* R	Significance of R	F	df	Significance Probability **
1 & 13	.292	.063	2.14	14/223	(.01, .02)
2 & 14	.269	.152	1.50	14/223	(.1, .25)
3 & 15	.214	.572	.82	14/226	ns
4 & 16	.347	.003	1.46	14/226	(.1, .25)
5 & 17	.361	.001	1.82	14/227	(.025, .05)
6 & 18	.271	.128	1.31	14/227	(.1, .25)
7 & 19	.204	.654	.91	14/226	ns
8 & 20	.210	.604	1.36	14/226	(.1, .25)
9 & 21	.231	.445	2.19	14/218	(.005, .01)
10 & 22	.228	.471	.89	14/218	ns
11 & 23	.276	.131	1.21	14/218	(.25, .5)
12 & 24	.274	.152	1.28	14/213	(.1, .25)

* from analysis of pooled T_c and T_o' data to compute SS_{12}.

** the significance probability falls in the given interval

ns means the significance probability is .5

Table is based on data from two plants of Organization VI

The second procedure used to investigate across time variation compares the values predicted for TVE for months 13 through 24 using equations for months 1-12 with observed values of TVE for months 13-24. The steps involved are as follows:

1) compute the prediction equation for the combined data from 2 Plants of Organization VI using T_o S.O.O. and criterion scores for each month, namely $\hat{Y}_k = B_0 + \underline{B}_k\underline{X}$;

2) compute the prediction equation and multiple R using T_o' S.O.O. and criterion scores, namely $\hat{Y}'_k = B'_0 + \underline{B}'_k\underline{X}'$. This R is the maximum relationship that we would expect between observed criterion scores at T_o' and predicted values of these scores;

3) compute the predicted T_o' criterion scores using the equations computed at $T_o + k$ and the S.O.O. measured at T_o', namely $\hat{Y}''_k = B_0 + \underline{B}_k\underline{X}'$;

4) compute the correlation between $\hat{Y}'$ and $\hat{Y}''$. This correlation is compared to the R from step (2).

The results of this analysis are given in Table 4-2. The general pattern suggests no consistent <u>linear</u> relationship between the predicted and actual values of TVE for the second year.

There are two possible reasons for this lack of agreement between predicted and observed performance. The first is simply that the human system has changed considerably over time and the relationships developed at $T_o + k$ do not predict well at $T_o' + k$. Given our previous discussion of substantive limitations on our investigation this is a likely explanation and the lack of agreement is not a surprise.

The second reason involves statistical artifacts which limit the degree of agreement which might be found. These have been discussed previously and we will mention only one additional factor which arises from the imputation of criterion scores. As a result of imputation, each observed criterion score is identical across all work groups in a cost center. Each predicted criterion score differs according

Table 4-2

CORRELATIONS BETWEEN PREDICTED AND ACTUAL TVE SCORES

Month	Multiple R T_o'	Correlation $(\hat{Y}', \hat{Y}'')$	N
13	.45	-.24	128
14	.38	-.15	128
15	.35	-.04	127
16	.46	.14	127
17	.45	.18	128
18	.37	.00	128
19	.25	.02	127
20	.29	.00	127
21	.32	-.13	122
22	.36	.16	122
23	.36	-.07	122
24	.32	-.01	117

to the work group's S.O.O. scores at T_o'. The actual performance of any work group may be quite different from the performance of its cost center which determines the imputed scores. Thus we might predict each work group's actual performance relatively accurately while making a poor prediction of its imputed score. The relative loss of predictive power due to this effect is a function of the performance score variance within and across cost centers. As variance of work group scores within cost centers increases and variance of cost center scores decreases, the constraint on the relationship between predicted and observed (imputed) work group scores becomes more severe.

It seems likely that both the substantive and statistical constraints are operating to some degree. That is, if the statistical limitations were eliminated,

the observed relationships would be less than the expected maximum (R for T_o') but greater than they are at present.

Summary

Two different statistical procedures tended to support somewhat different conclusions about the applicability of predictor-criterion relationships developed at $T_o + k$ for prediction at $T_o' + k$. Given these results, and the statistical and substantive limitations upon the investigations, it is impossible to conclude that relationships observed at $T_o + k$ are or are not applicable at $T_o' + k$. Despite the inconclusive results, two important points are evident from the analyses and associated discussion. First, further research, where many if not all of the noted constraints can be controlled, is needed to address the issue of variation across predictor measurements. Second, the substantive constraints enumerated herein are not unique to these Organizations. Given this, the prediction equations will most probably require continual monitoring and updating. Finally, it may be that some measure other than the accuracy of predictions needs to be developed to evaluate the utility of a particular set of prediction equations.

V. SUMMARY AND CONCLUSIONS

The basic purpose of this research has been to explore and demonstrate the Current Value Approach to human resources accounting. This has required the development of methods necessary to operationalize the theory behind the Current Value Approach as set forth by Likert (1973), Likert and Bowers (1973), Bowers and Pecorella (1975), and others. Once developed these methods have been applied to a data set to demonstrate them in a concrete situation. The presentation of the value attribution process completes the initial development and demonstration of the Current Value Approach. We have shown that it is possible to predict changes in operating costs which will result from observed changes in the human organization. Whether it is practical to apply the Current Value Approach in any particular setting is a function of the setting and the "state of the art" of the methodology. One particularly pertinent aspect of the setting is the magnitude of the dollar values invoived. The dollar values computed in this demonstration indicate that in at least some settings these values are large enough to warrant serious attention.

At present, the "state of the art" of the Current Value methodology is somewhat analagous to the initial development of a process for manufacturing some new chemical product. The chemist first develops a process which, in his laboratory at least, will yield some of the desired product. After this initial development a considerable amount of work may be required before large scale industrial production can begin. Similarly, we have demonstrated that under certain conditions the Current Value Approach can be used to estimate the dollar value of an organization's human resources. Whether or not this can be done on a regular basis in an operating organization will depend on the answers to a variety of issues. It is the identification and resolution of these issues that is the next step to

the utilization of the basic methodology developed herein. Many of these utilization issues have been raised in previous reports (Pecorella and Bowers, 1976a; 1976b; 1977; Davenport et al., 1977). The development of the value attribution process and the results of its demonstration also suggest several utilization issues. The remainder of this section will be devoted to summarizing the major utilization issues raised by the present report. This will serve both to summarize the findings of the report and provide an initial step toward a future report dealing with utilization issues.

Utilization Issues

Perhaps the most important utilization issue suggested herein is the accuracy of values produced by the value attribution process. The analyses in Section IV attempted to evaluate the accuracy of the predictions using a subset of the data from the main body of the research. These analyses, although not conclusive, suggest several issues which merit further investigation. These issues include characteristics of the criterion measure and sample size. In addition to the tentative findings of Section IV, the results of two steps of the value attribution demonstration (Section III) raise questions about the results of that demonstration. These two steps are: 1) the prediction of change in organizational effectiveness criteria, summarized in Tables 3-9 and 3-11; and 2) the determination of the current value of these changes, summarized in Tables 3-20 and 3-21. Briefly, Tables 3-9 and 3-11 show somewhat sudden changes from one period to the next in magnitude and/or direction of predicted changes in TVE and ABS. Table 3-20 shows a predicted savings in TVE. This is what we would expect given the general increase in S.O.O. scores shown in Table 3-2. Table 3-21, however, shows a mixture of predicted savings and increased expenditures, predominantly the latter, for ABS. This is not what we would expect given the same pattern of general increase in S.O.O. scores for the work groups involved. It is to these three features of the

results: 1) the potential lack of accuracy suggested by Section IV; 2) the variance of predicted criterion changes; and 3) the mixed, but generally unexpected, current values for ABS, to which we shall address ourselves in the context of three general utilization issues.

1. Organizational Effectiveness Criteria

The availability of reliable and valid performance data is one of six conditions necessary for the implementation of the Current Value Approach (Pecorella and Bowers, 1976a, p. 10). The demonstration of the value attribution process emphasizes three necessary characteristics of the organizational effectiveness measures.

a. Validity. The effectiveness criteria must be valid from two perspectives. First, they must measure the underlying dimensions of organizational effectiveness: volume, cost, quality and efficiency (Pecorella and Bowers, 1976a) in an accurate manner. The ability to measure these underlying dimensions includes a sensitivity to changes in any or all of the dimensions. Second, the effectiveness criteria must be affected by changes in the state of the human organization. In the present study, four ultimate criteria (TVE1, TVE2, DLC1, DLC2) were examined and TVE1 was selected as the measure with the best relationships to the S.O.O. (Pecorella and Bowers, 1976a; 1976b). Even this measure, however, had bivariate relations with individual S.O.O. indices which were at best moderate and which included a number of "directionally incorrect" relations. As a result, the multivariate relationships developed to use as prediction equations had moderate R's and explained anywhere from 7% to 32% of the TVE variance. The S.O.O. also had moderate relationships with the penultimate criterion, ABS, with 10% to 30% of the ABS variance explained. Some of the reasons for these moderate relationships, e.g., the imputation of cost center performance scores to work groups, are clear.

Other causes, e.g., peculiar organizational practices, can only be guessed at. Whatever the causes, however, the effects include the reduced accuracy found in Section IV and possibly the unexpected increased expenditures predicted for ABS in Table 3-21.

b. Reliability. Reliability of criterion measures was also an explicit concern from the start of this research. Clearly, unreliable criterion measures would reduce the size of the multiple R's observed between the S.O.O. and the measures. In order to increase reliability of the TVE and ABS measures, multi-month performance periods were defined. A performance period consisted of consecutive months where the performance measures were relatively similar to each other and dissimilar to other months. Each cost center's performance score for a period was defined as the mean of its performance measures for each month in the period. Because the method chosen to increase the reliability of the criteria, i.e., definition of periods, has important effects on the results of the value attribution, we shall consider it in some detail.

Performance periods were defined using Smallest Space Analysis (Lingoes, 1965; Guttman, 1968). SSA is a non-metric technique which plots variables in multi-dimensional space on the basis of the similarity or dissimilarity of the variables. Similar variables are plotted closer together. The measure of similarity that is used determines which aspects of the variables will be examined. Consider the situation where we have four cost centers (A-D), each with performance measures for four consecutive months (e.g., January, February, March, April). Figure 51 shows the profile of performance measures across the four cost centers for each month. Nunnally (1967, p. 373) identifies three types of information in such profiles: 1) the level of each profile, characterized by the mean score of all cost centers in each month; 2) the dispersion of each profile, characterized by the standard deviation of cost centers' scores in each month; and 3) the shape of the

profile, characterized by the rank order of performance scores in each month. Different similarity measures capture different types of information. The Pearson r implicitly standardizes the variables (mean = 0; S.D. = 1); therefore it reflects only similarities in profile shape and ignores level and dispersion. Thus, the SSA used to define the performance periods, which was conducted using the Pearson r as a measure of similarity (Pecorella and Bowers, 1976a), grouped months into periods solely on the basis of the shape of the profiles. In our example in Figure 5-1, January and February would have been clustered together, as would March and April. While the example is intentionally extreme, the effect is the same: performance months defined as similar may have had considerably different means and variances. The specific effect of this procedure on the definition of the performance periods and subsequently on the regression equations is unknown. It would seem, however, to merit further investigation.

Figure 5-1.

Monthly Cost Center Performance Profiles

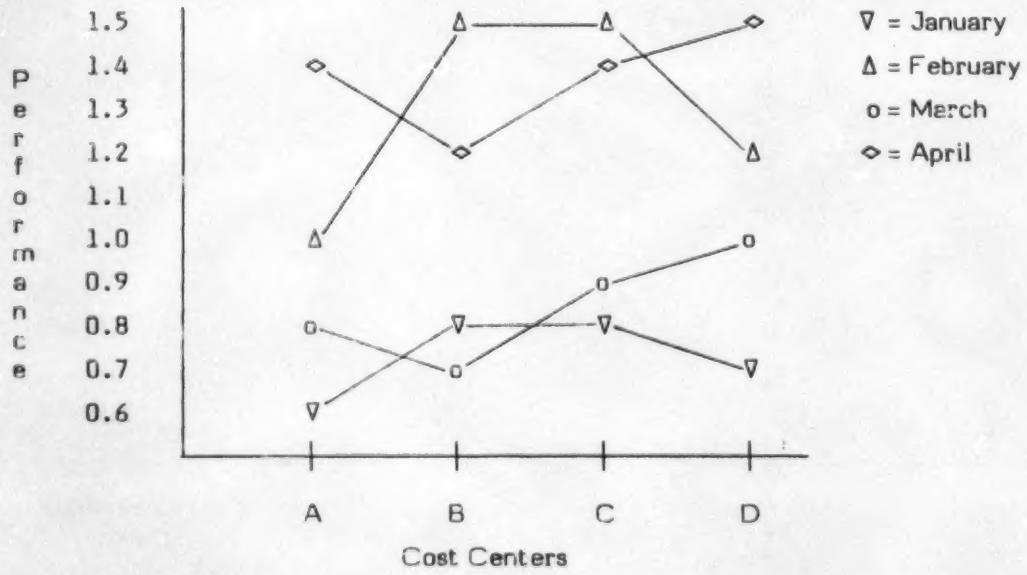


Table 5-1

CORRELATION BETWEEN PERFORMANCE SCORES IN CONSECUTIVE TVE AND ABS PERIODS

	Consecutive Periods							
	B-C	C-D	D-E	E-F	F-G	G-H	H-I	I-J
TVE	-.02	.51	.59	-.31	.17	.11	.24	---
N	183	576	700	267	59	59	59	---
ABS	.51	-.16	-.26	.08	.35	-.01	-.32	-.63
N	474	73	73	363	419	372	369	369

Since performance periods were defined as (consecutive) months for which the r's were relatively high compared to months not in the period, we would expect the r's between adjacent periods to be relatively low. These adjacent period r's, computed across all work groups which had data for the relevant pair of periods, are shown in Table 5-1. As is expected these correlations are generally low, particularly for ABS. (Those r's which are high are inflated by the identification of a lengthy performance period which was subsequently labeled as two different periods. For example, see TVE period D/E for Organizations II and IV in Pecorella and Bowers, 1977, p. 22.) These low r's have a predictable effect on the prediction equations developed. For any two consecutive periods, two generally different sets of performance scores are regressed on the same set of S.O.O. predictor scores (ignoring, for the moment, the problem of different organizations having performance data for different periods). Since the regression defines linear

combinations of S.O.O. scores which best predict the criteria, and the criteria are quite different from one period to the next, we can expect the linear combintations, i.e. the estimated beta coefficients, to be quite different from one period to the next. Examination of Table 3-3 confirms this. When one uses these b's to make predictions for each period, using the same set of S.O.O. scores, one would expect considerable variance in the predictions from one period to the next. This is precisely what we find in Tables 3-9 and 3-11. The generally greater variation in ABS predictions (Table 3-11) is to be expected, given the generally lower inter-period r's for ABS. The problem of different Organizations having data for different periods is addressed under the issue of the size of the data set.

Thus, while attempting to increase criterion reliability, the definition of performance periods has introduced some unanticipated effects, some known, others only suspected. These effects, while not necessarily deleterious, need to be investigated further, particularly in the context of the overall accuracy of the prediction equations.

c. Valuation of Criterion Measures. The previously cited work of Macy and Mirvis (1976) and Mirvis and Macy (1976) indicates the importance of carefully defining performance measures so that: 1) their dollar value can be accurately determined and 2) the costs of various measures are mutually exclusive. The valuation portion of the value attribution demonstration underscores the importance of these considerations. Our use of a data set in which either the criterion measures had not been so defined or the information relating the criteria to dollar values was not available necessitated the use of numerous assumptions. While the assumptions were all reasonable given the available data, it is clear that we were at best able to roughly estimate the actual dollar costs. Furthermore, this estimation procedure was unable to estimate differences in the dollar costs of criteria among various cost centers. Finally, because the TVE and ABS criteria and

cost relationships were not defined in a mutually exclusive manner, there is some unknown degree of overlap in the TVE and ABS values shown in Tables 3-20 through 3-22.

2. Size of the Data Set

There are at least two reasons why the number of cases (N) available for development of the prediction equations is an important issue. In the present study, the efforts to provide an adequate N resulted in identifiable problems in the development of the prediction equations and consequently in the value attribution. First we will briefly discuss why the N is an issue and then describe the associated problems in the value attribution demonstration.

The purpose of having a large N is to compute prediction equations which will be replicable. The probability of replicating current analyses is indicated by the significance level of the results. Perhaps the most common situation occurs when a relationship is observed in a presumably random sample and the analyst is interested in whether or not the results would be replicated in a different sample from the same population. When the analysis is multiple regression, an N that is small relative to the number of predictors will produce an artificially inflated R due to the loss in degrees of freedom. This is reflected in the significance attained. The larger the number of predictors, the larger the N required to obtain results that are likely to be replicated. In the context of implementing a Current Value system, this condition might arise if a set of prediction equations were being developed using a small number of work groups.

The situation encountered in the present example is somewhat different than the one described above in that the variables were measured for all cost centers. Therefore, it would seem, the replicability of any observed relation would not depend on inferential statistics because we have actually observed the relationship

for the entire population of interest. This position, while appealing, ignores the fact that we desire the observed relationships to be replicable on the same work groups, but at different times. Our arguments in Section IV, regarding the dynamic nature of the S.O.O. - performance relationship, suggest sampling the same work groups at a variety of time points if the observed relationships are to be useful in the future. This is essentially what was suggested in Section IV when the need for multiple observations of the S.O.O. - criterion relationship was noted.

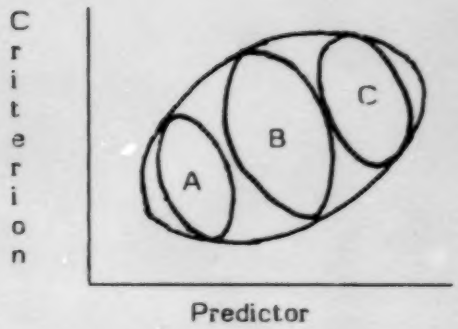
There are then two different, yet related, issues involving the number of cases in the analysis. Too small an N at any single point in time will artificially inflate the R. Inadequate sampling across time may mean observed relationships are not replicable at subsequent points in time.

In the present research, the problem of obtaining an adequate N at a single point in time was approached by two means. Cost center performance scores were imputed to all work groups in the cost center. This has been discussed previously. In addition to imputation, data from several Organizations were merged into a single data file for analysis. Some potential effects of this have previously suggested. For example, Davenport et al. (1977) found that inclusion of certain organizational characteristics, such as size, in the prediction equation added to the strength of the relationship. The possibility of interaction effects was noted in Section II of the present report. Yet another phenomena that might occur is the "ecological fallacy". This is the situation where the predictor-criterion relationship across organizations is of one sort but is different within each organization. Figure 5-2 shows an example of this situation with one predictor and three organizations. In Figure 5-2 the relationship is positive across organizations (A, B and C) but negative within each organization. It might even be that including data from several organizations serves as a surrogate for including data from a single organization at several points in time and increases the likelihood of replicability in

the future. In an implementation, one point of interest would be whether or not the predictions are to be developed using data from a single or multiple organization. Similarly, if the data is to come from a single organization, it may be desirable to investigate differences across sub-units of that organization.

Figure 5-2.

Ecological Fallacy



The major observable effect of including data from multiple organizations in our demonstration is a result of the fact that different Organizations had data available for different performance periods. Thus, when computing the prediction equations for each period, different subsets of the total multi-organization data set were used. These subsets were in no sense random. Given this, we might expect changes in the equations (b's) as a function of which data were being used in any particular period. Furthermore predictions were made for all work groups with T_o and T_o' S.O.O. scores, regardless of whether data from their Organization was used to develop the prediction equation for any single period (see p. 24). We might expect the predicted changes to be most accurate for those work groups belonging to Organizatio from which data were used in computing the prediction equation. For example, data from Organization II were included when computing the

equations for TVE periods C, D, and E only (Davenport et al., 1977, p. 18). We would expect the TVE predictions for Organization II to be most accurate for these three periods and less accurate for other periods. While we have no way to assess the accuracy of our predictions for each work group (given imputation of cost center scores and general lack of performance data at $T_o' + k$), we would generally expect predictions to be negative given the overall increase in S.O.O. scores noted earlier. If one defines a negative prediction as at least directionally correct, we see that for Organization II, periods C, D and E (in Table 3-9) have directionally correct predictions, as expected, while periods F, G, H and I have directionally incorrect predictions. Overall, for those TVE period-organization combinations in Table 3-9 where performance data was originally available to compute the prediction equation, 82% (18/22) of the predictions are directionally correct; while in those cells where the Organization had no data used in the computation of the equation, only 50% (10/20) of the predictions are directionally correct. Of these ten "unexpectedly" correct predictions, five occur in Plant 2 of Organization VI. These may be due to the fact that for four of these five periods, Plants 1 and 3 of Organization VI did contribute to the equations. For ABS (Table 3-11) a similar pattern can be observed. Those period-organizational cells where the organization contributed to the development of the equation have 52% (13/25) directionally correct predictions while the cells where no data were available from the Organization have 20% (3/15) directionally correct predictions. It seems reasonable to conclude that predictions for Organizations which contributed to the development of a prediction equation are more accurate than for those Organizations which did not contribute. This "dropping in and out" of Organizations across periods and the definition of performance periods are two likely causes for the somewhat erratic pattern of predicted criterion changes observed in Tables 3-9 and

3-11. Both these problems are more severe for ABS and are probably a major reason why the ABS predictions in Table 3-21 tend to be positive instead of negative.

3. Theoretical Model

The third and final utilization issue has to do with certain theoretical aspects of the Current Value Approach. Actually, there are two theories involved. The S.O.O. is based upon a model which posits certain causal, intervening and end result variables as key aspects of organizational functioning. Given this theory of organizational functioning, the Current Value Approach proposes to measure the worth of the human organization as the dollar value of the difference between estimates of organizational effectiveness at two different points in time. This difference is calculated from observed changes in the state of the human organization and previously observed relationships between this state and effectiveness.

There are two aspects of the theory of organizational functioning that are especially relevant to utilization issues raised by value attribution. The first is the existence of time lag. This phenomena was identified in a previous report (Pecorella and Bowers, 1977) and has been an essential part of this study. The time lag between S.O.O. administration and the maximum value of R was found to be approximately 18 months for these data. Our predictions were made for zero through 12 months because this is when the most data (for computation of prediction equations) from the most organizations were available and because of the simplicity of predicting for a period of one year following measurement. In an implementation, however, differential availability of performance data to develop prediction equations would probably not be a consideration. The convenience of predicting, for example, for the next fiscal year would have to be balanced against the timing of strong relationships.

The second feature of the theory is the relatively large number (13 to 16) of variables used to describe organizational functioning. This large number of variables requires a larger number of cases to obtain stable prediction equations. Condensation of these variables to their underlying dimensions might reduce the number of predictors without substantially effecting the R. It is also possible that different predictors or subsets of predictors have their strongest relationship to the criterion at different time lags. For example, variables near the end of the causal chain might predict best shortly after S.O.O. measurement but have virtually no relationship to the criterion 24 months later. The reverse sequence might hold true for variables at the start of the causal chain. If this were found to be the case, then equations involving different subsets of the predictors could be developed for different values of time lag.

The theory of the Current Value Approach as developed thus far calls for estimating the change in effectiveness as the difference between two least squares estimates of effectiveness. An alternative method might be to use the relationship between the S.O.O. change scores and the change in effectiveness. In this procedure, an observed change in the effectiveness criterion would be regressed on an observed change in S.O.O. scores. This would require an additional year (or whatever time period elapsed between S.O.O. measurements) for development of the equations. It could, however, be easily accomplished in the context of an operating, continuously updated Current Value system.

Conclusion

It has been shown that the Current Value Approach to Human Resources Accounting is possible. The practicality of the Approach depends on the satisfactory resolution of several utilization issues raised in this and previous reports. The issue of predictive accuracy is highlighted by the present findings.

Certain features of the data used herein, e.g. low to moderate predictor-criterion relationships; definition of performance periods and the use of data from multiple organizations, compose one set of identifiable influences that reduce the accuracy of predictions in the value attribution demonstration. Refinement of the model of organizational functioning used, particularly in terms of the relationship of specific predictors to criteria, may also offer some opportunity for increased accuracy. The next step in developing the Current Value Approach is an enumeration and discussion of outstanding utilization issues with an emphasis on identifying methods for their research and resolution.

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Appendix A

The equivalency of predicting $\hat{Y}$ directly and through standard scores can be shown as follows.

Consider letting $Z = \frac{Y-\bar{Y}}{S_y}$ and regressing Z on X to yield the prediction equation

(1) $\hat{Z} = a_1 + b_1 X.$

To return $\hat{Z}$ to raw score form, one uses

(2) $\hat{Y} = \hat{Z} \cdot S_y + \bar{Y}$

The resulting predicted scores ($\hat{Y}$) are the same as those computed by

(3) $\hat{Y}' = a_2 + b_2 X$

That is to say, $\hat{Y} = \hat{Y}'$.

Proof: From the equation to compute a_2 we have: $a_2 = \bar{Y} - b_2\bar{X}$, allowing us to rewrite (3) as

(4) $\hat{Y}' = b_2(X-\bar{X}) + \bar{Y}.$

Similarly, a_1 is given by $a_1 = \bar{Z} - b_1\bar{X} = -b_1\bar{X}$, allowing us to rewrite (2) as

(5) $\hat{Y} = [b_1(X-\bar{X})]S_y + \bar{Y}.$

Now, by definition

$$b_1 = \frac{\Sigma (X_i-\bar{X})(Z_i-\bar{Z})}{\Sigma (X_i-\bar{X})^2}$$

$$= \frac{\Sigma (X_i-\bar{X}) Z_i}{\Sigma (X_i-\bar{X})^2}$$

$$= \frac{1}{S_y} \cdot \frac{\Sigma (X_i-\bar{X})(Y_i-\bar{Y})}{\Sigma (X_i-\bar{X})^2}$$

$$= \frac{b_2}{S_y}.$$

Substituting into (5) we have

$$\hat{Y} = \frac{b_2}{S_y}(X-\bar{X})S_y + \bar{Y} = b_2(X-\bar{X}) + \bar{Y} = \hat{Y}'$$

QED.

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